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March 1961

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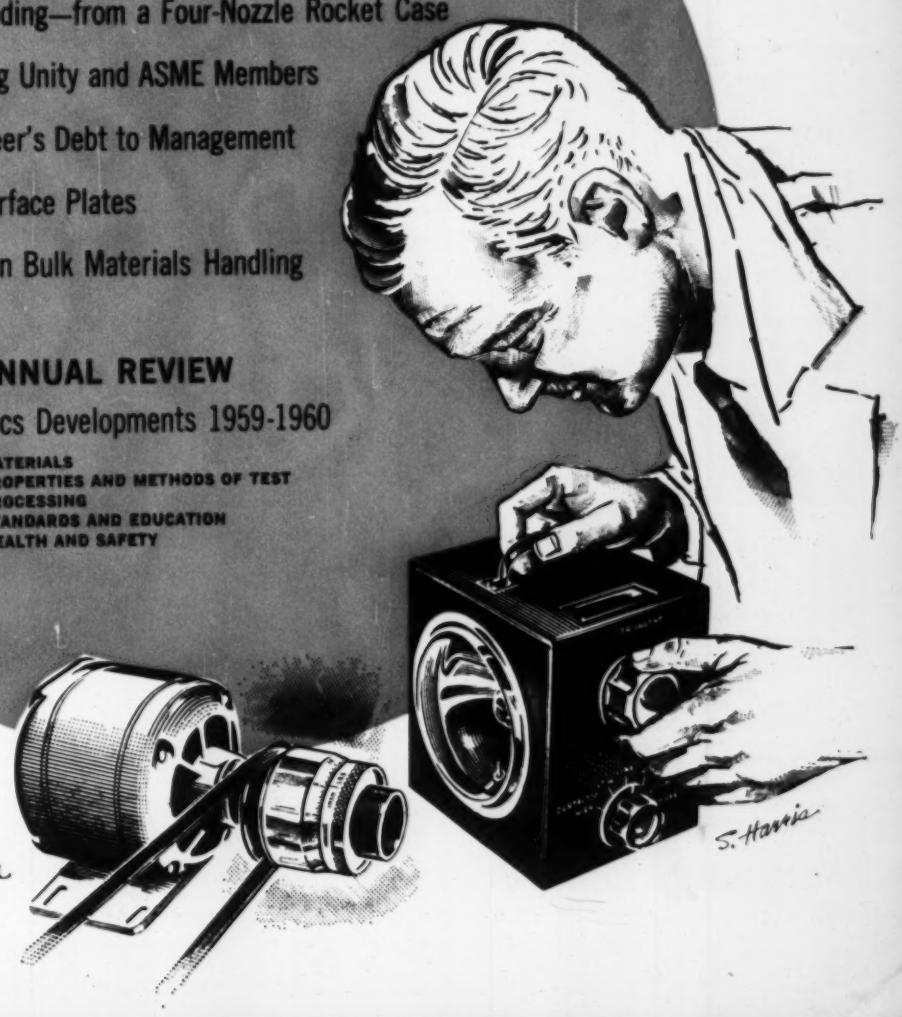

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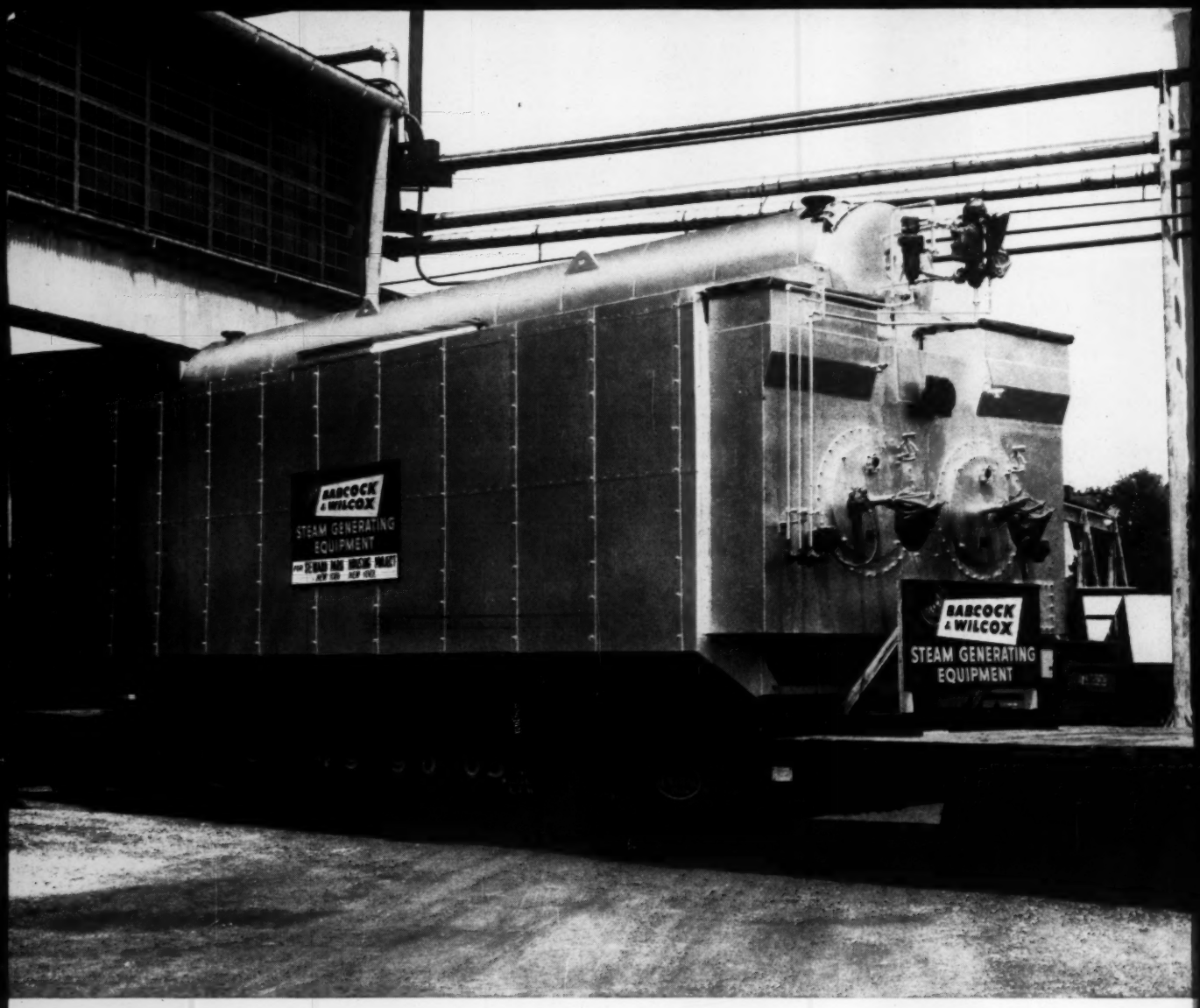

THIS SINGLE UNIT HEATS 1,728 HOMES

B&W 100,000 lb per hr Boiler was shipped "SHOP ASSEMBLED"...ready to go to work

This shop-assembled B&W FO Package Boiler—shipped as a single unit—is handling an important job.

The FO Boiler supplies all the steam to heat a new $22 million, 1728 family cooperative apartment house in New York City. Simplicity of installation is only one of the FO Boiler's attractive features: just remove it from the flatcar or truck, make the necessary connections, and start it up.

This natural circulation boiler delivers up to 100,000 lb of steam per hour. It's B&W designed, to give you reliable high capacity with minimum maintenance in a small space. If you have a problem involving steam, B&W—with nearly a century of experience in the design and manufacture of steam generating equipment—will be delighted to help you. Just write to The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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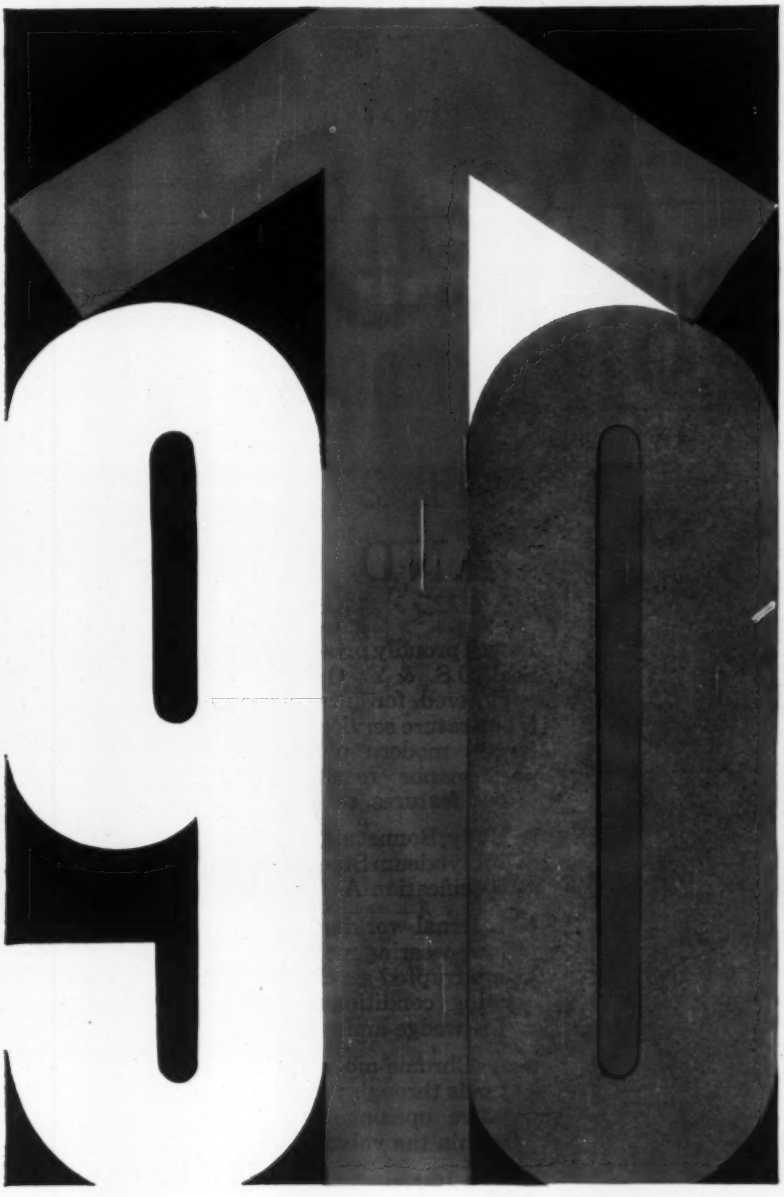

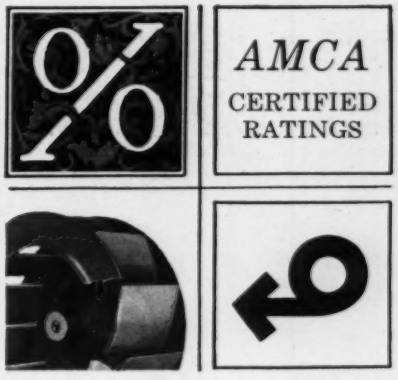

New Airfoil Bladed Fans exceed 90% efficiency

It's here now—a new line of Airfoil Bladed Fans from American-Standard Industrial Division . . . all carrying the AMCA certified rating seal! A completely new design, these Airfoil Bladed Fans employ a highly efficient, quiet fan configuration ideally suited for general ventilation and industrial process applications. High mechanical efficiency, over the entire fan selection range, means the lowest possible power requirements. Get the complete story. Send for Bulletin A-1103 today. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Ltd., Toronto, Ontario.

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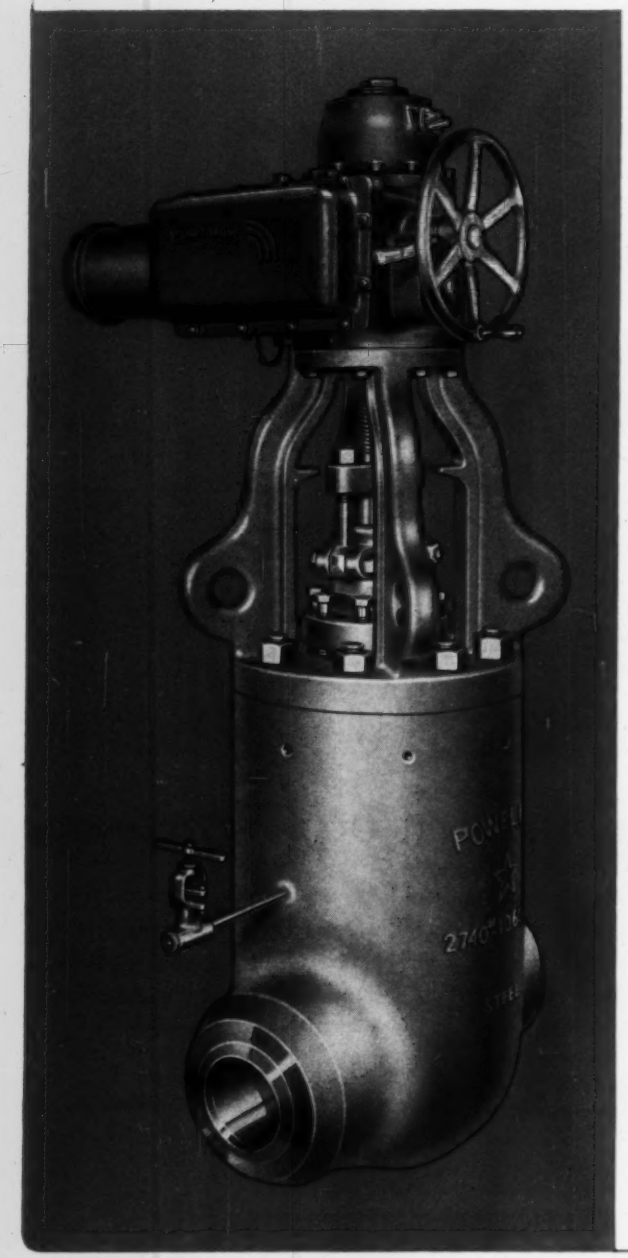

AT 2740 psig AND 1060° F

Powell proudly presents this new Pressure Seal O.S. & Y. Gate Valve, especially engineered for ultra high pressure-high temperature service in one of the nation's largest modern plants. Its outstanding performance results from many key design features, such as:

- Body, Bonnet and Wedge of Chromium-Molybdeum Steel, according to ASTM specification A-217, Grade WC9.
- Internal working parts constructed of long-wearing materials, proven for uninterrupted service under severe operating conditions. Stellite facings on the wedge and seat rings.
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- The top mounted weatherproof Electric Motor Operator, for remote control, has a *Spring* that automatically compensates for the changes of contraction or expansion of the valve stem, wedge and body. Proper and precise seating at all times is assured.

Development of this new high pressure-high temperature gate valve is positive evidence of Powell's ability to meet any industrial valve requirement—with regular or special designs—in bronze, iron, steel or alloys—for water, oil, gas, steam, and corrosive service. For further information or assistance, consult your nearby Powell Valve Distributor, or write direct.

MECHANICAL ENGINEERING

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THE COVER

How much torque? How much power? You can measure electric-motor loads by applying this little dynamometer with its stroboscopic tachometer. Micro Pump Corporation of Danville, Calif., developed the device which has a collet that can be tightened on the shaft by hand. The V-belt pulley is adjustable in diameter. The stroboscope reads rpm, and also "stops" the torque meter so the operator can read the torque while the machine is rotating. Horsepower can then be read from a chart. Accuracy: Within half of one per cent.

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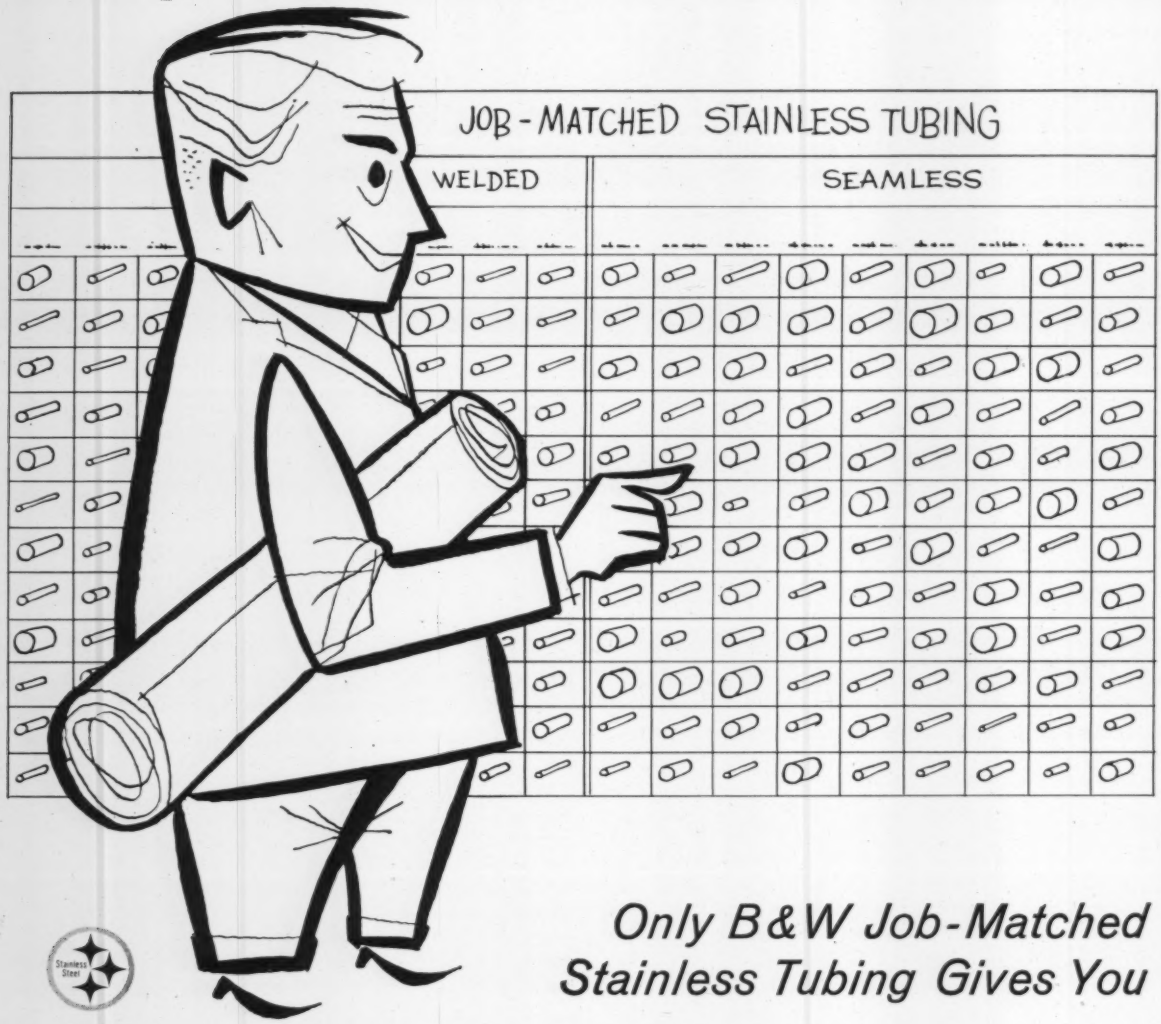

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GRAPHITAR®

(CARBON-GRAPHITE)

FOR DEPENDABILITY

GRAPHITAR'S own character makes it dependable. A non-metallic engineering material, formed from carbon and graphite powders and a special binder, compacted under high pressures and furnaced at temperatures up to 4,500°F., GRAPHITAR possesses inherent characteristics that give finished parts exceptional dependability. GRAPHITAR'S natural heat resistance, for example, gives bearings, seals, vanes and rings exceptional dependability whenever dependability is one of the prime requisites.

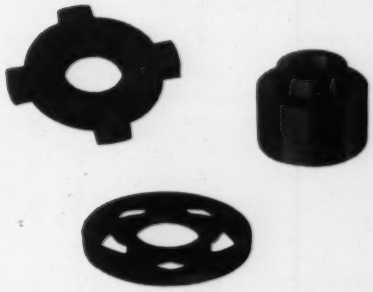
There are other characteristics every bit as important to GRAPHITAR'S dependability. They include chemical and magnetic inertness, mechanical strength and adaptability to self-lubrication. Besides these natural characteristics, GRAPHITAR engineers can control porosity, strength and hardness to match GRAPHITAR'S physical properties to each individual application. It's little wonder that GRAPHITAR has become one of the design engineer's most versatile and useful materials.

In this laboratory test stand, oxidation-resistant GRAPHITAR parts are being checked under simulated operating conditions. Similar tests have proven that, when GRAPHITAR parts are exposed in oxidizing atmospheres at 1,200°F., they show only a weight loss of less than six percent after 200 hours.

In the Engineering Department of The United States Graphite Company, micro-photo studies are indispensable in the study of internal part structure. The Metallograph is just one of dozens of modern technological aids employed in both the quality control of production GRAPHITAR parts and in the research and development of new products. GRAPHITAR parts are engineered for dependability.

GRAPHITAR air/oil seals employed in today's high-speed turbojet engines have established an enviable record for operating dependability. Installed on the main shaft of the turbine, GRAPHITAR seals successfully withstand tremendous shaft speeds and generated heat.

GRAPHITAR bearings in the power reactor pumps of American nuclear submarines have compiled an outstanding record for dependability.



Unusually shaped parts of GRAPHITAR can be molded easily with today's modern techniques. Ears, face slots and outside diameter notches of friction disc above, left, were molded in one operation without need for secondary machining and finishing.

Do you have an application in which GRAPHITAR'S dependability can help solve a tough problem, reduce your costs and improve the operational life of your products? Our engineering staff can help you find out. Our field men can also give specialized, on-the-job consultation. Send for your free copy of Engineering Bulletin #20. Included is helpful information about the properties, characteristics and applications of GRAPHITAR.

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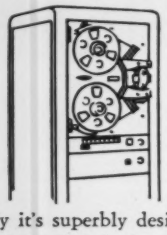
A WORD OF WARNING ABOUT THE NEW ALLUREMENTS OF RECOMP II [and a modest word about price]

Could you be enticed by a computer? Surprisingly, there *are* businessmen and scientists who have allowed their emotions to get quite out of control regarding Recomp II.

And now there is more reason than ever for becoming enamored with this amazing computer. *Three* reasons, to be exact, and all of them new. Hence, our warning to you.

The first reason is, in itself, enough to steal your heart away: it is Recomp II's new reduced lease price. Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at significantly lower terms. And it *still* provides the identical quality, solid-state performance, and features that can't be found on computers costing three times what Recomp II *used* to cost.

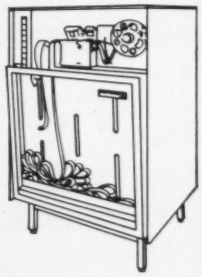
This is heady stuff—but even more enticements lie in wait. You can now add an optional modification to your Recomp II to enlarge its capacity by using magnetic tape. Here you see the new Recomp Magnetic Tape Transport unit.



Naturally it's superbly designed, solid state throughout. But don't let its quietly well-bred air fool you; it has a memory that would stagger an elephant—over 600,000 words. And up to eight of the Transport units can be connected to Recomp II, giving you a computer with a total memory capacity of over 5,000,000 words. Steady there, Mr. Simpson!

The speed of this new magnetic tape control is something to applaud, too: read and write speed is 1850 characters a second; bidirectional search speed is 55 inches per second. Do you begin to see why we warned you about these new allurements of Recomp?

Below you see another new optional feature for your Recomp II: the Facitape tape punch and reader console. It punches 150 characters a second, reads 600 characters a second, and stops on a character. It adjusts to read and punch from 5



through 8 channels. It is versatile, accurate, fast, simple-to-operate, economical, reliable. And it has perfect manners: the mechanical components are completely enclosed in a soundproof housing.

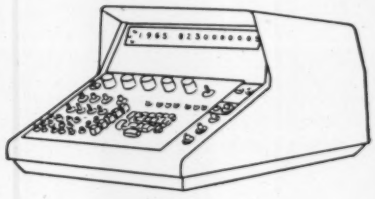
But lest we harp too much on the *new* features of Recomp II, perhaps we had better remind you of some of the extraordinary features that Recomp II *already had*. Features that have always made it the finest computer in the low-priced field.

1] Recomp II is the *only* compact computer with built-in floating point arithmetic. It defies being hemmed in on a problem. With its large capacity it obviates computer-claustrophobia.

2] Recomp II was the first solid-state computer on the market. As you can see by the new features above, Recomp II's scrupulous engineers have seen to it that it remains the *finest* solid-state computer on the market.

3] Recomp II seems to have more built-in features than a dream home kitchen. It has built-in square root command. Built-in automatic conversion from decimal to binary.

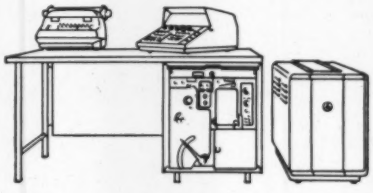
Here you see Recomp II's distinctive keyboard. It looks easy enough to operate—and it *is!* And because Recomp II



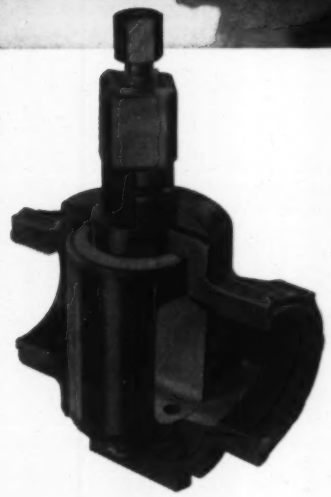
requires no specialized talents, anyone with computer problems can be taught to use it.

One look at Recomp II leaves little wonder that even practical people have allowed their hearts to influence them in choosing Recomp II. Without being showy, it is an object of beauty that reflects its supreme precision of performance. Its distinguished exterior bespeaks the ultimate of excellence; *c'est sans pareil.*

But if you want to avoid being captivated by a computer you should know how strong your emotions will run. May we suggest a *test?* Expose yourself to Recomp II. See it in action. Touch it. Feed problems into it. This is the only way to know how you will react to this extraordinary computer. Make a date to see Recomp II right away.



Write AUTONETICS INDUSTRIAL PRODUCTS, Dept. O37, 3400 E. 70th St., Long Beach, Calif.
The Autonetics Division of North American Aviation, Inc.



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Wherever service is demanding, or interruptions are costly, specify the valves that *can't wedge* — ACF Lubricated Plug Valves.

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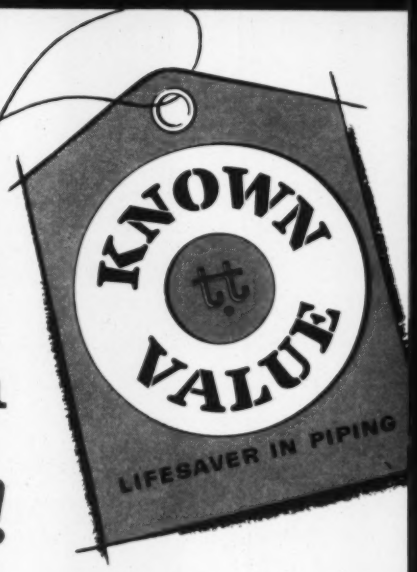

There was never a time when *known* value was so important, when *extra* care was so necessary in buying components for welded piping systems. It is a time when you must make sure TUBE-TURN quality goes into your job, not merely into your specifications.

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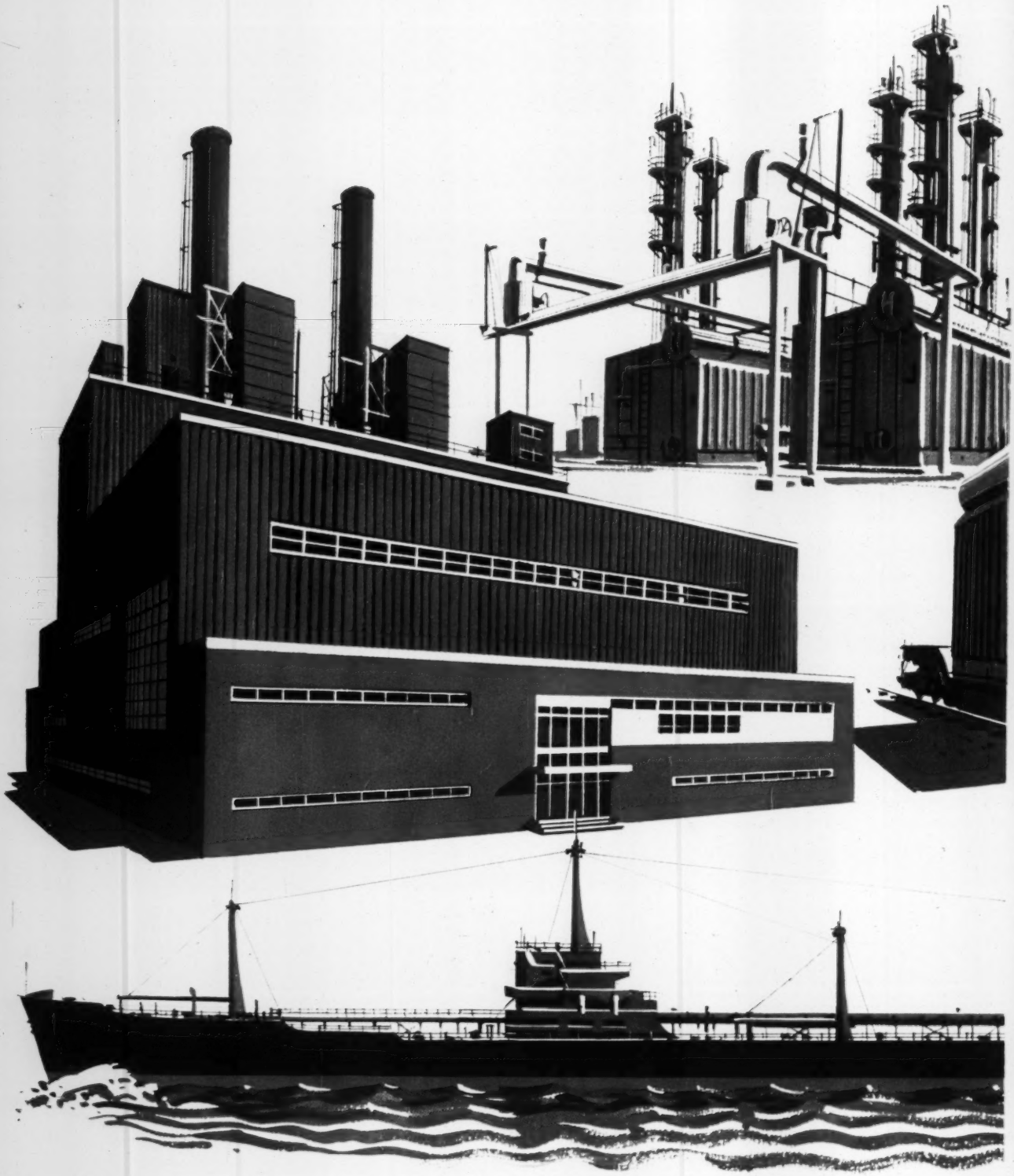
TUBE-TURN Welding Fittings And Flanges Are Stocked By And Sold Exclusively Through Authorized Distributors.

More service with less paperwork

More savings getting pipe installed

More dependability and satisfaction



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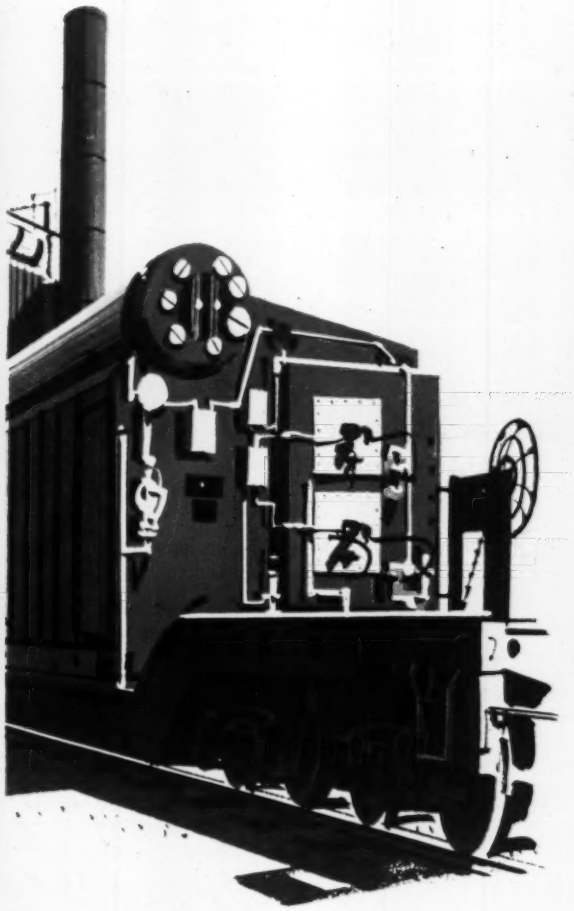
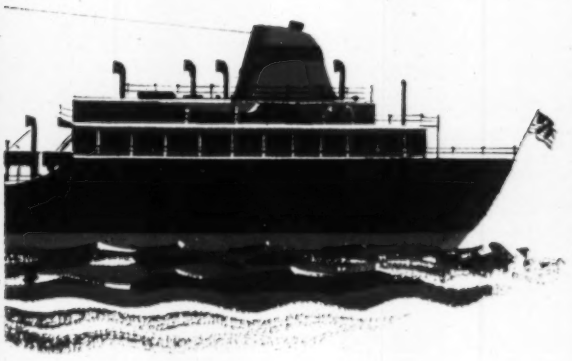




A broader power base to serve you

Through contributions in every field where steam power is used, Foster Wheeler has accumulated knowledge and experience that are yours today in all Foster Wheeler equipment and services.

FW-built steam generating units are identified with the central stations of leading U.S. utilities. Foster Wheeler has designed, engineered and built more nuclear steam generators and pressurizers than any other manufacturer in the world. And FW is the leading U.S. supplier of marine steam generating equipment.

In factories, oil refineries, chemical plants and every other type of installation requiring useful heat, Foster Wheeler is in the top rank of companies supplying heat transfer and steam power equipment.

When such equipment becomes your need, assure yourself of the benefit of FW's broader experience with the *full range* of steam producing components.

FW engineers, fabricates and erects them all: utility and industrial steam generators, feedwater heaters, steam condensers, evaporators, pulverizers, cooling towers, specialized pressure vessels and industrial processing plants. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.

FOSTER FW WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

Now... a completely self-cased, MODULAR BOILER

C-E's NEW

DESIGN HIGHLIGHTS OF THE VU-60

Modular construction makes it possible to assemble custom designs from standardized components.

Boiler can be proportioned for best combustion, heat absorption and gas flow even when space conditions are limited or difficult.

Completely self-cased, the VU-60 is an all-welded gas-tight and pressure-tight envelope of finned furnace and boiler tubes. This results in less non-working weight per pound of steam capacity.

No external ductwork. The bottom of the boiler is a plenum chamber which allows air to flow direct from the air heater to the burner windbox.

Number of field-welded pressure parts is greatly reduced.

Cross flow baffling and symmetrical boiler bank mean low draft loss, no sluggish gas flow in any pass.

Requires only a simple, reinforced concrete slab. No conventional roller supports required.

Paneled construction cuts erection time.

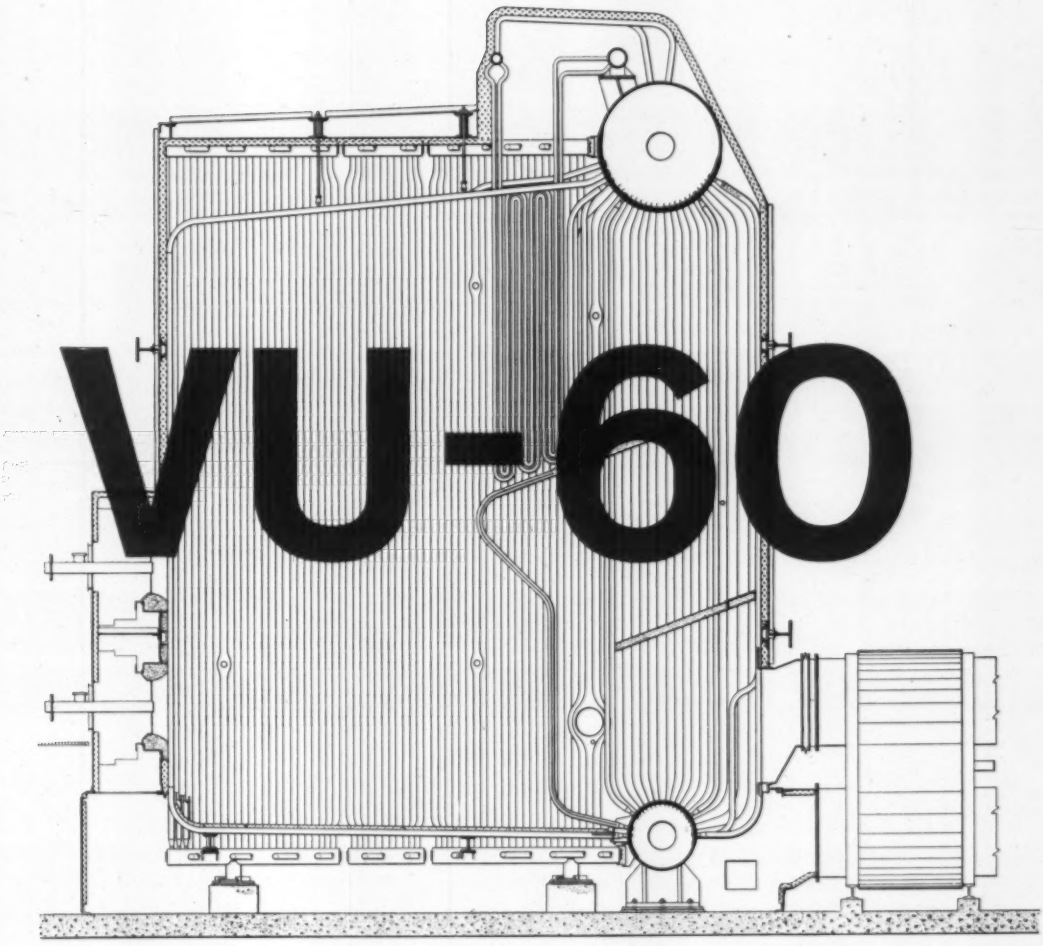
No air heater supporting steel is required.

For pressurized or induced draft firing. When pressurized, unit does not require induced draft fan.

VU-60 SPECIFICATIONS

Capacities:	100,000 to 250,000 lb per hr
Design pressures:	250, 500, 750, 1000 psi
Steam temperatures:	To 900 F
Fuels:	Oil and/or gas
Firing:	Horizontal (front wall) or tangential
Size increments:	Depth — twelve Width — eight Height — three
Steam drum sizes:	Four

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



The VU-60 Boiler is a new and logical extension of C-E's service-proved VU series. Like all VU units, it is completely integrated, symmetrical in design, uncluttered and uncomplicated. Based on a standardized modular concept, it offers greater flexibility, yet stays within the bounds of solid and proven practice.

The VU-60 is a functional boiler. Completely self-cased, the exterior walls of this unit (furnace and boiler) are composed of finned tubes, shop welded into panels. The fins between panels are field welded to form a gas- and pressure-tight structure. Insulation is applied directly to the outside of these walls and is covered by pre-formed, field installed metal lagging. Thus non-working weight and bulk is reduced to a minimum.

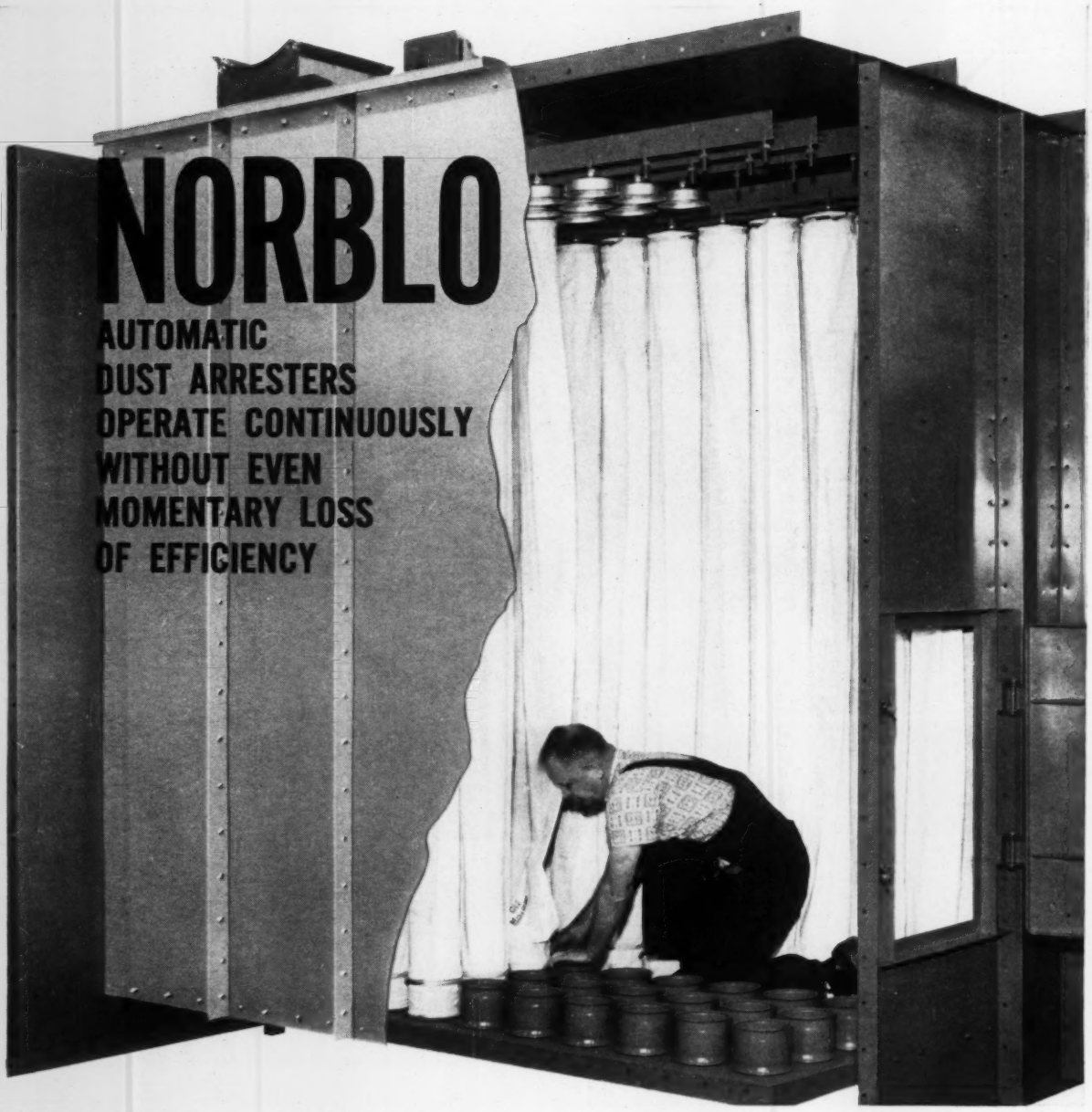
The VU-60 is economical, it is dependable, it is accessible. It is easy to install and will meet your most exacting steam needs. Why not write for further information, or, if you prefer, contact the C-E office nearest you.

COMBUSTION C·E ENGINEERING

General Offices: Windsor, Conn. • New York Offices: 200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd. C-300

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



Periodic cleaning, repair or replacement of bags, and minor maintenance can be accomplished while the collector remains in operation. One compartment, as shown above, can be isolated in the Norblo design, with all mechanical parts outside the gas stream. Continuous cyclic shaking, by compartment, allows operation without interruption. ■ This is why in modern plant operations you'll find an increasing preference for Norblo Automatic Bag Arresters. Where efficient production requires continuous operation more and more industries specify Norblo Dust Arresters. Over 80% of the cement industry relies on Norblo equipment for drying, grinding and finishing operations. ■ Buell-Norblo equipment can play an essential part in your process. Write for complete information on any type of dust collection problem. Buell Engineering Company, Inc., Dept. 35-C, 123 William Street, New York 38, New York. Northern Blower Division, 6421 Barberton Avenue, Cleveland, Ohio. Electric Precipitators · Cyclones · Bag Collectors · Combination Systems · Fans · Classifiers.

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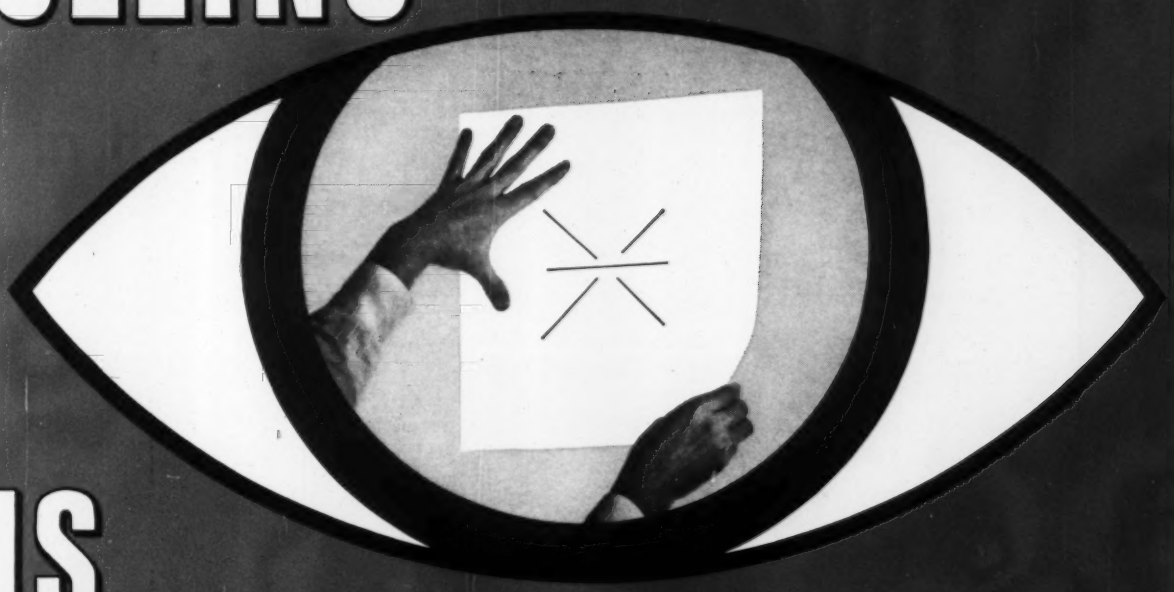

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Try Clearprint's perfect working surface with a HB pencil, then with a ruling pen. Lines are sharp and clean—no feathery edges.

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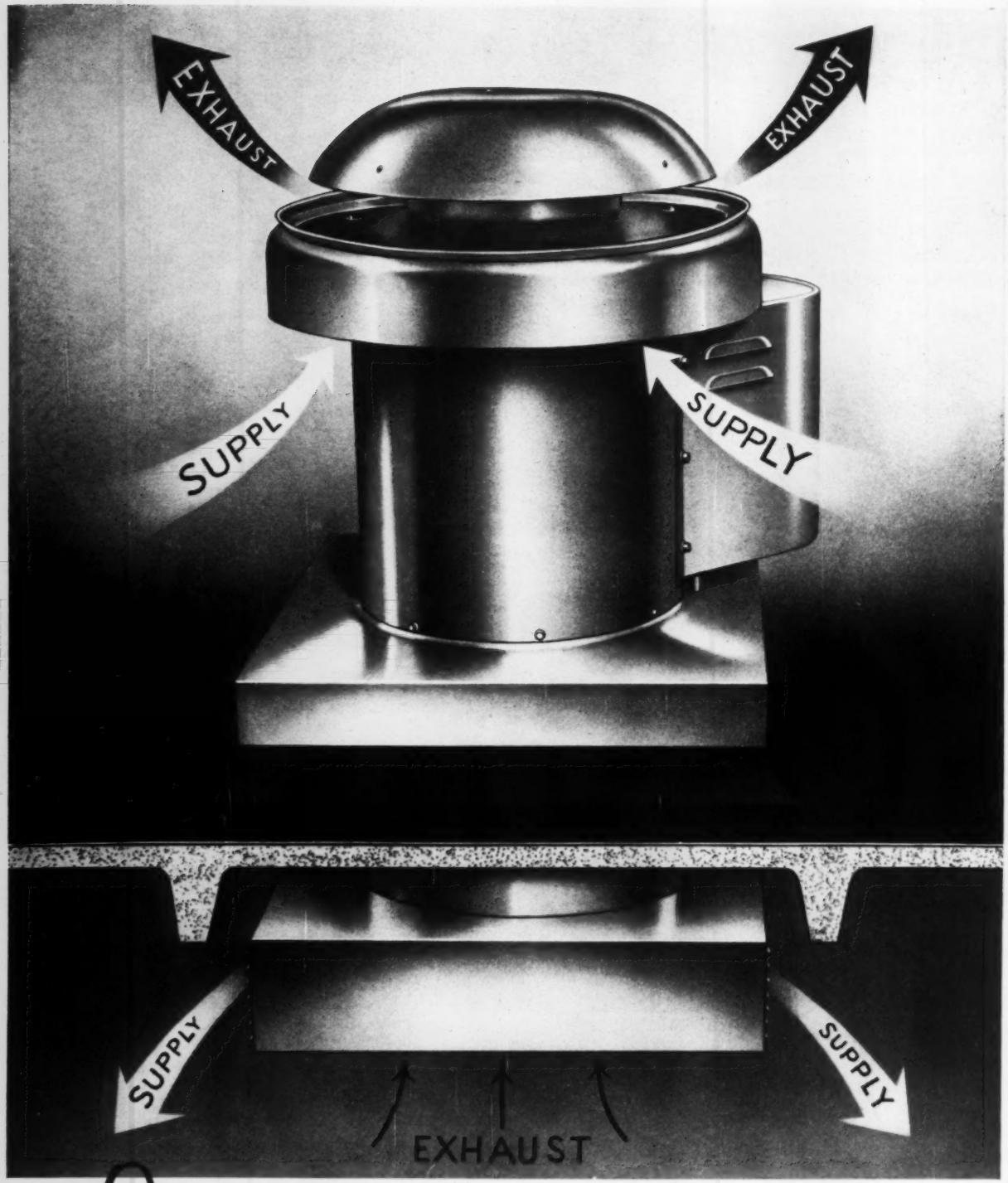

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You get both air supply and exhaust simultaneously with the new Clarage TWINALATOR*. Unique, superior dual function air handling for all types of buildings. Definite money-saving advantages: Requires only one opening, one motor, one drive, one starter. No make-up air unit necessary. Applications unlimited — well adapted to closed or semi-closed systems. Can be provided with heating coils and filters. Write today for Bulletin 552. CLARAGE FAN COMPANY, Kalamazoo, Michigan. Clarage sales engineering offices are located in all principal cities.

*Patented
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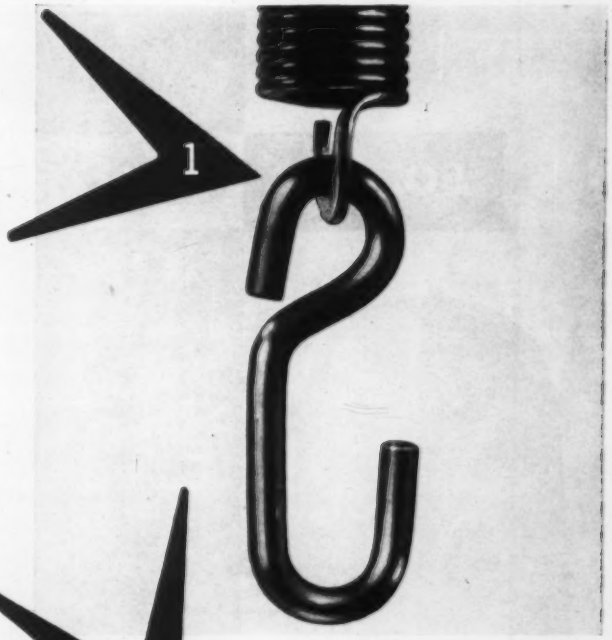
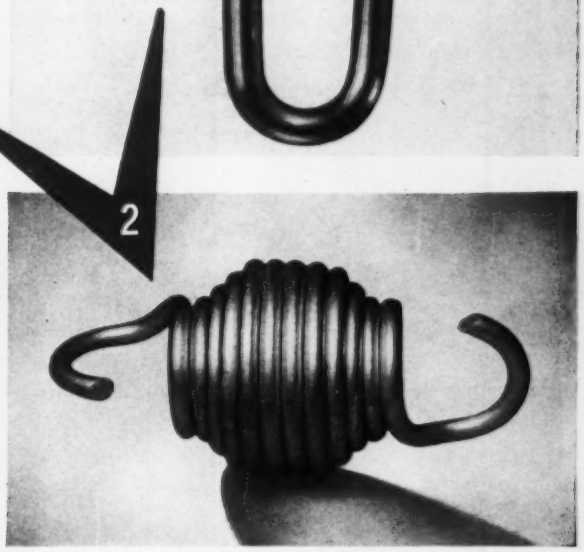
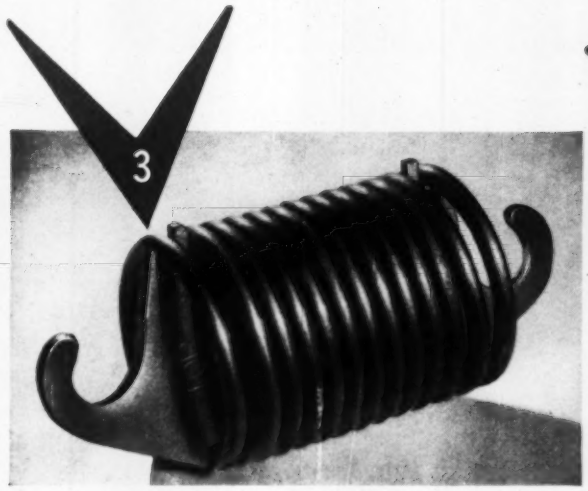
Why it pays to look at the end in the beginning







1. In this pick-arm spring for a textile machine, natural frequency vibration plus rigid end restraint caused early failure. By redesigning spring and adding swivel hook to end assembly, failure was avoided and cost reduced as well.

2. Fatigue failure caused by bending stresses occurs where end hooks join working coils. In this method of reducing the combined stress, two coils at each end are wound with a reduced diameter.

3. Another method for reducing stress concentration where end hooks join coils is to thread a flat stamping into end coils.

Here are a few examples of why it pays to call on the springmaker early in your design problems. End-hook failure of extension springs is a common occurrence that experience can help avoid. Check your specifications for performance and production economy by consulting an A.S.C. spring engineer. Write for bulletin "How to Solve Your Spring Design Problems."

5903

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
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Ohio Division, Dayton, Ohio
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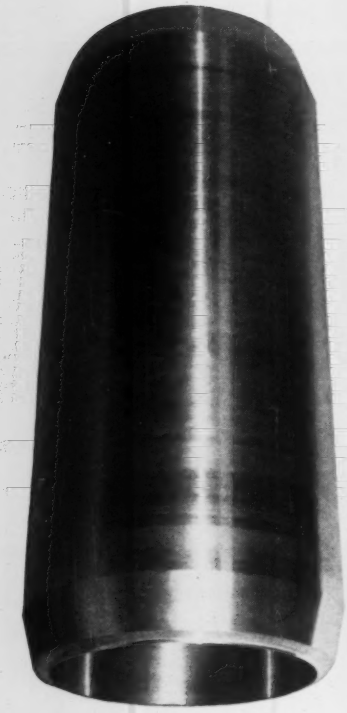
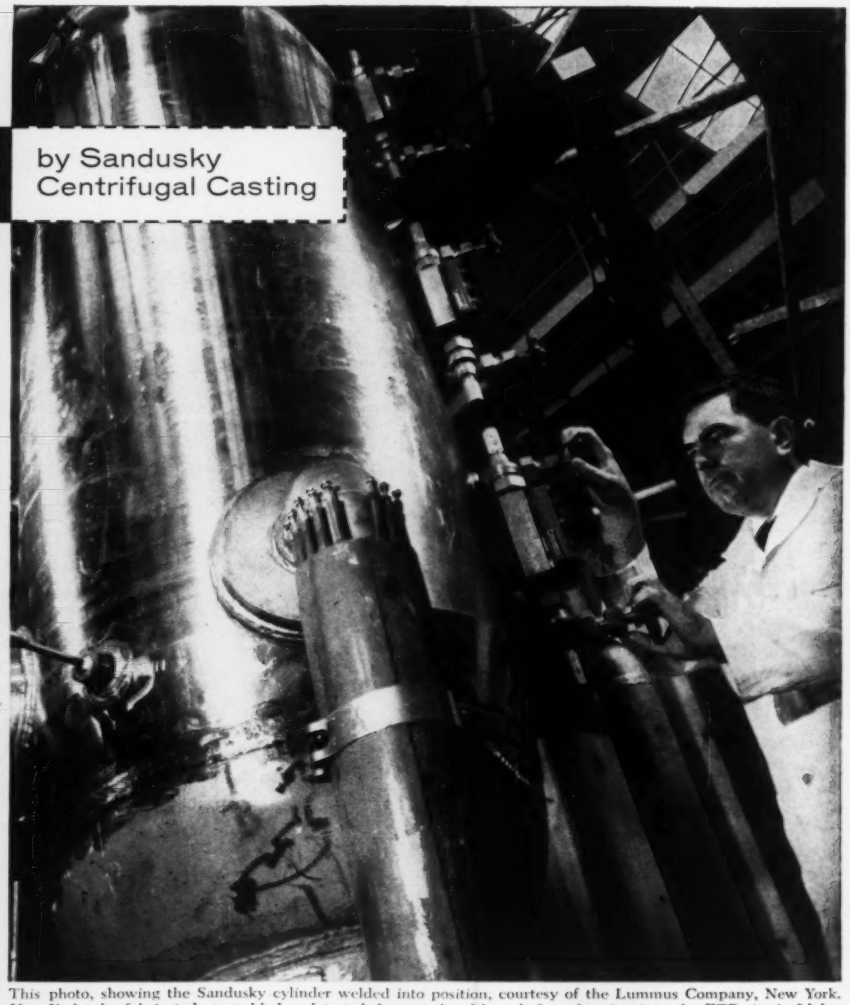
SOLVED: by Sandusky Centrifugal Casting





This photo, showing the Sandusky cylinder welded into position, courtesy of the Lummus Company, New York. New York who fabricated, assembled and tested the completed loop before shipping it to the ETR site in Idaho.

Nuclear Test Loop Uses Sandusky Centrifugal Casting as Pressurizer Cylinder

A Sandusky Centrifugal Casting is the main cylindrical component of an electrically heated pressurizer, designed by Knolls Atomic Power Laboratory to Section VIII, of the ASME Code (Unfired Pressure Vessels) for use in the new Engineering Test Reactor facilities at Idaho Falls, Idaho.

This 66¼" long cylinder, 27" O.D. with walls 2½" thick, was centrifugally cast of an 18-8 stainless steel (SA-351, Grade CF-8) for the extra corrosion resistance required under nuclear loop service conditions: demineralized water at temperatures to 650°F and pressures to 2500 PSI.

O. G. Kelley Co., Boston, to whom we delivered this 2-ton, fully machined cylinder, welded on the forged heads and nozzles, radiographed the welds, and hydro tested the completed vessel to 4300 PSI.

This is another example of the adaptability of Sandusky Centrifugal Castings to applications demanding the highest order of quality. They may well offer you a practical and economical answer to your cylindrical needs, also.

We are producing cylinders and piping in diameters from 7" to 54"—in lengths to 33 ft.—in a wide range of ferrous and non-ferrous alloys. Write for Bulletin 300, for more complete technical information on the Sandusky process and product application data.

SANDUSKY (S) *CENTRIFUGAL CASTINGS*

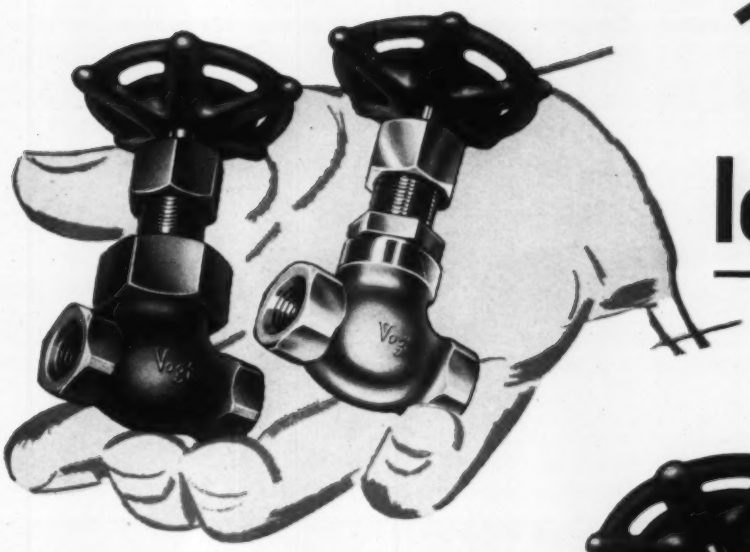
FOUNDRY & MACHINE CO.

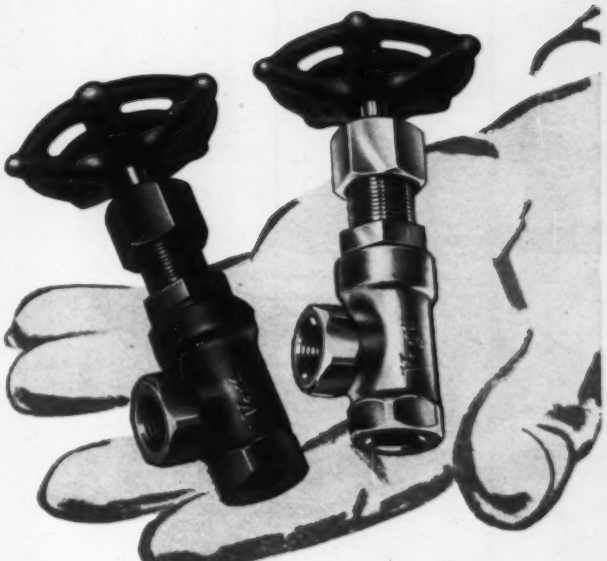
5903

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

New higher quality

New lower price





Enlarged production facilities combined with improved manufacturing techniques enable Vogt to pass on the effected savings to our customers.

Service proved — these valves have always been a standard of quality for meter and gauge line service. You no longer need to compromise for less because of price! Send for Folder GP-9 giving specifications and engineering data on both globe and angle types, forged from stainless or carbon steel for every meter and gauge line service.

Address Dept. 24A-FM

Vogt

HENRY VOGT MACHINE CO.
Louisville, Kentucky
SALES OFFICES: Camden, N. J., Charleston, W.Va., Chicago, Cleveland, Dallas, Los Angeles, New York, St. Louis.

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½′ x 11′ x 8′ PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

THE AIR PREHEATER CORPORATION

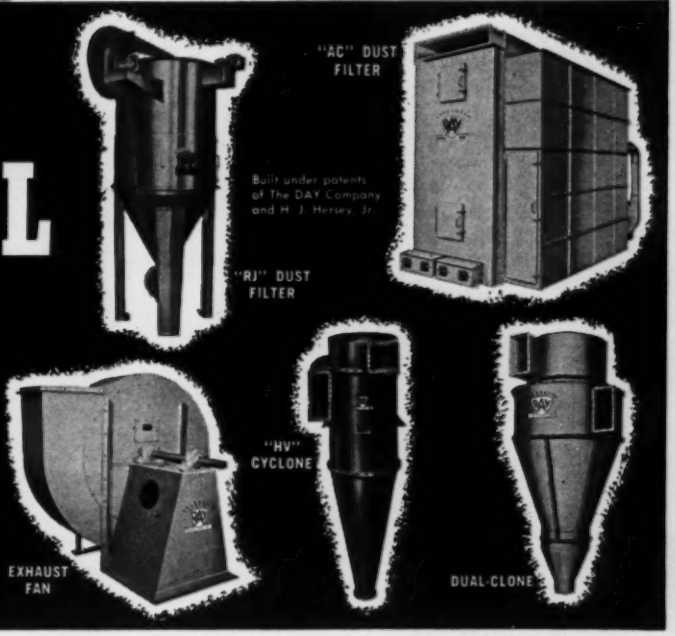
60 East 42nd Street, New York 17, N. Y.

DAY "RJ" dust filters and Dual-Clones on roof of Andersen Corporation *Windowall* plant, Bayport, Minn. This plant has 17 DAY dust collecting systems which include 21 DAY "RJ" dust filters, 20 DAY exhaust fans, 15 DAY Dual-Clones and more than one-half mile of piping. Over 50 tons of dust are removed via DAY systems each day. DAY equipment is flexible and easily adapted to changes in plant layout.

DUST CONTROL

THE WAY YOU LIKE IT!

- *Efficient*
- *Trouble-free*
- *Economical*



No two dust problems are identical . . . that's why it will pay you to consider DAY *engineered dust* control. Laboratory research, 80 years of practical experience and a *guaranteed approach* to efficient dust control are some of the reasons why companies of every size decide on DAY dust control. DAY offers a *complete* line of dust control equipment . . . seven types of collectors or filters — 166 different models . . . one is sure to solve your dust problem exactly, efficiently and economically.

Complete DAY service includes:

1. A field survey of the problem
2. A recommended solution
3. An engineered layout of equipment and/or system
4. Fabrication of equipment, piping, suction hoods, etc.
5. Installation
6. A GUARANTEE OF RESULTS

Whether you need equipment only or a complete system — contact DAY

FREE! HELPFUL, DETAILED INFORMATION ABOUT DAY Dust Control. Check and mail coupon toDAY. You'll receive free folders about DAY dust control equipment.

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Please send information on:

☐ "RJ" Dust Filter ☐ "AC" Dust Filter ☐ Exhausters ☐ "HV" Cyclones ☐ Dual-Clone

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COMPANY NAME_____

ADDRESS_____

CITY_____ STATE_____

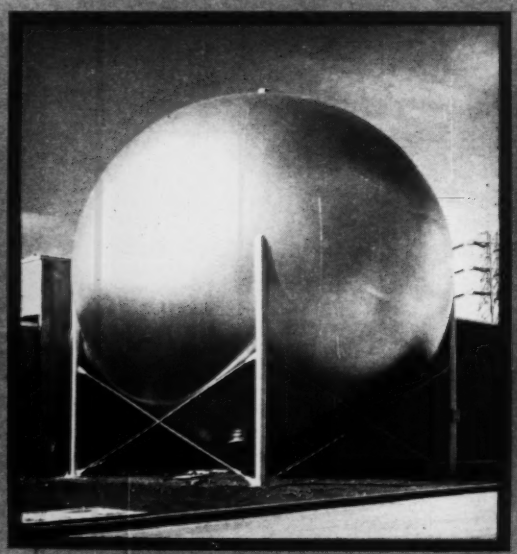
HORTONSPHERE
helps advance missile technology

The flight of a ballistic missile entering the earth's atmosphere is simulated in an Atmosphere Entry Simulator built by the National Aeronautics and Space Administration at Ames Research Center, Moffett Field, California.

Employing the Ames Simulator, space scientists quickly and economically determine in the laboratory whether a specific design can survive re-entry.

CB&I fabricated and erected several vital components for this important research facility. Included are a 30½ ft. diameter steel vacuum sphere and a 10 ft. diameter duct and elbow.

Craftsmanship in Steel—skillfully developed by CB&I over more than seven decades—builds quality into plate structures for any kind of service.



CB&I fabricated and erected steel vacuum sphere (left) and 10 ft. diameter duct and elbow (below, far right) for the Ames Atmosphere Entry Simulator.

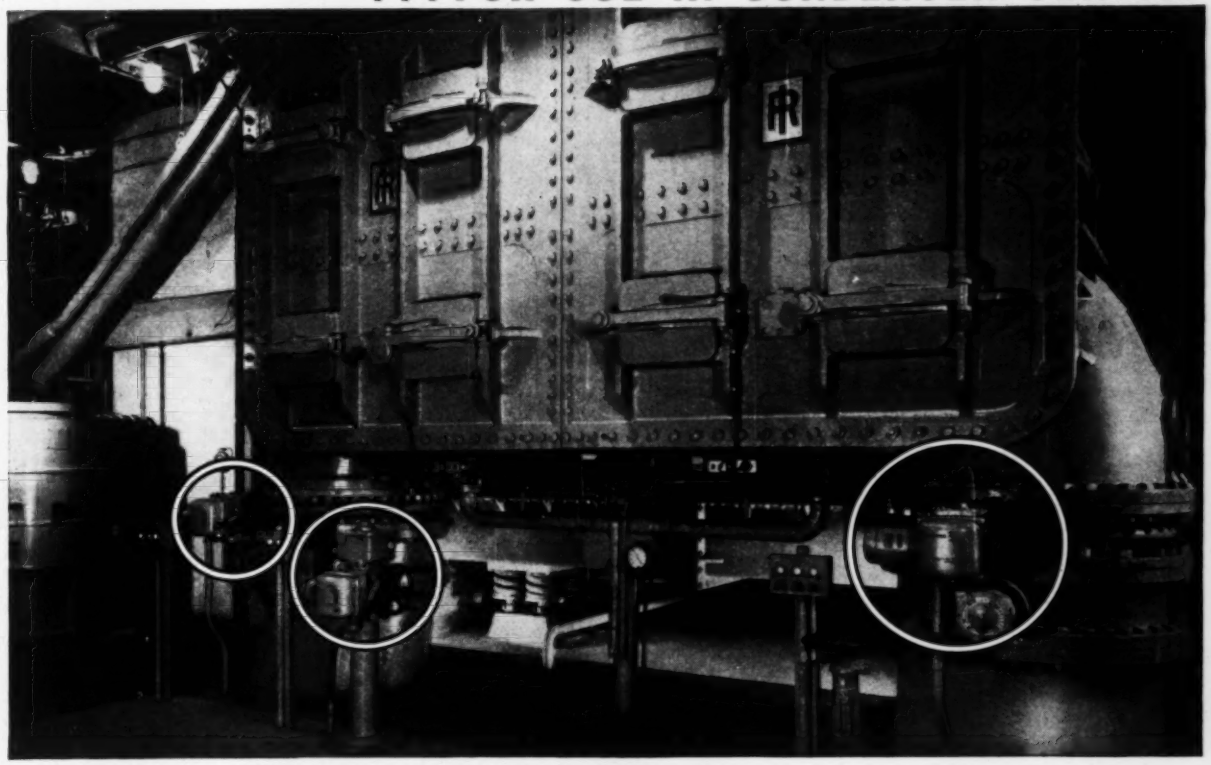
E66CB

CB&I

Chicago Bridge & Iron Company
332 South Michigan Ave., Chicago 4, Ill.
Offices and Subsidiaries Throughout the World

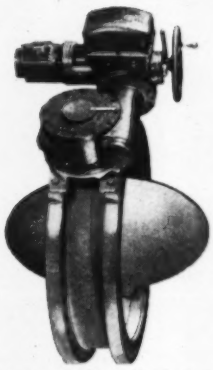
LimiTorque

...FOR USE IN CONDENSER SERVICE



...on Three IR Rectangular Condensers

...in large West Coast Steam Plant



Send for Bulletin #15-60, and please use your Business Letterhead when requesting a copy.

Above is shown one of the three Ingersoll-Rand space-saving Rectangular Condensers which serve the three 100,000 k.w. Generating Units in a large, well-known West Coast Steam Plant. Each Condenser contains 50,000 square feet of surface. Six I-R vertical pumps push nearly 270,000 gallons of cooling water per minute through the LimiTorque operated Butterfly Valves and the condenser tubes. The condensate is handled by six other I-R vertical pumps.

It is highly significant that LimiTorque Valve Operators are used in practically every Central Station and Large Industrial Power Plant built during the last twenty-five years—because of their absolute accuracy and reliability.

Where automatic, remote Valve Operation is required, LimiTorque will provide rapid, precise, safe and dependable control, under all operating conditions . . . and, remember too, LimiTorque can be field-mounted on most all existing valves. For specific applications, consult your Valve Manufacturer or nearest LimiTorque Sales-Engineering Office.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

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KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.

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INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

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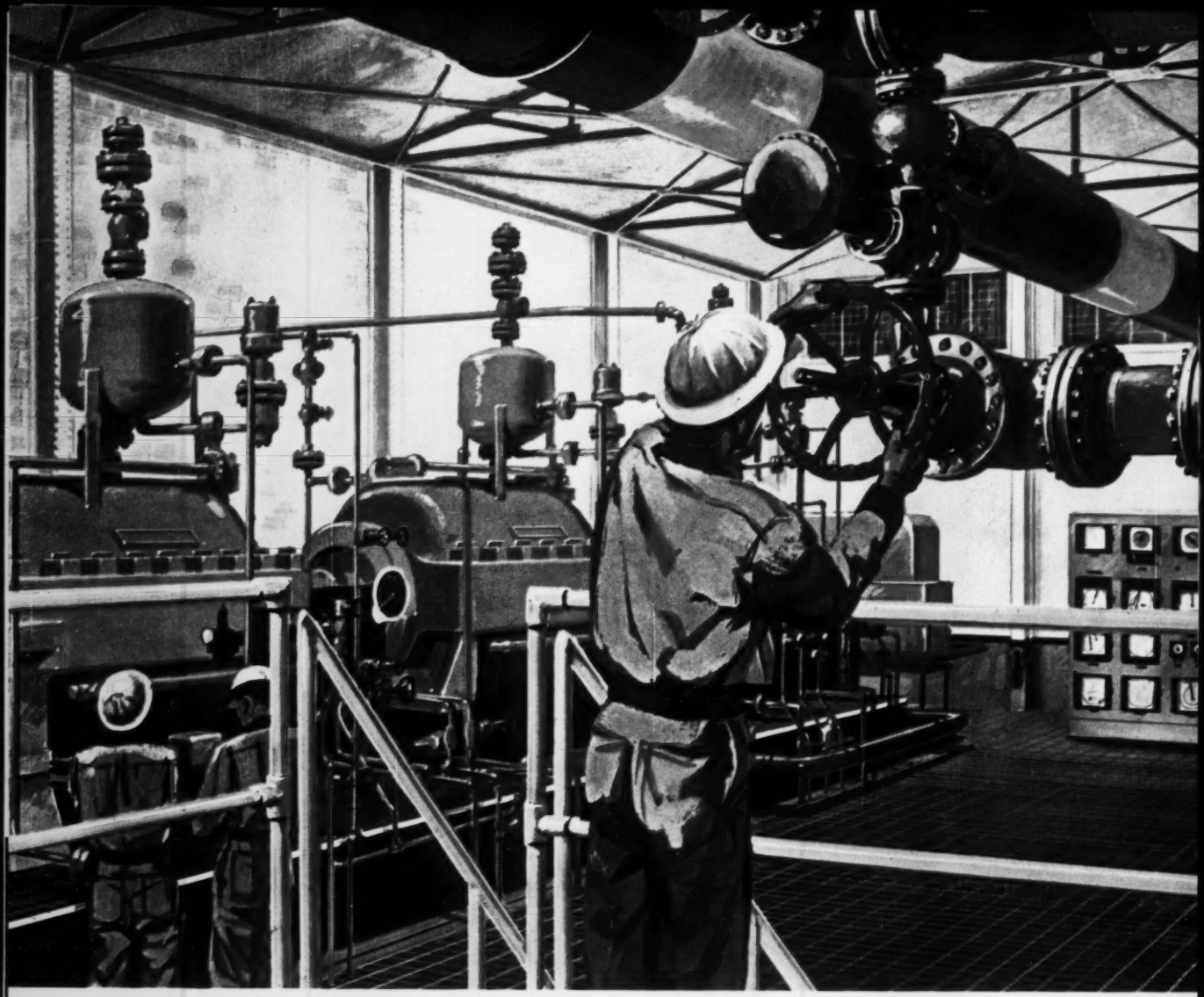

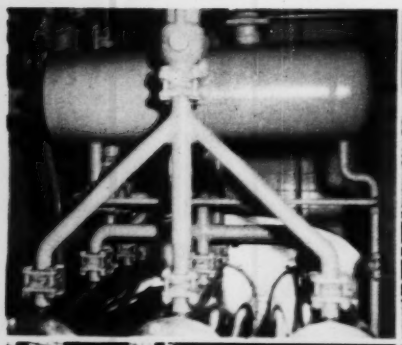

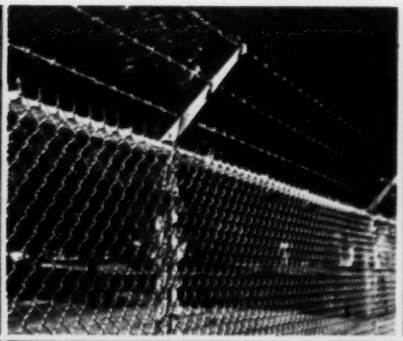

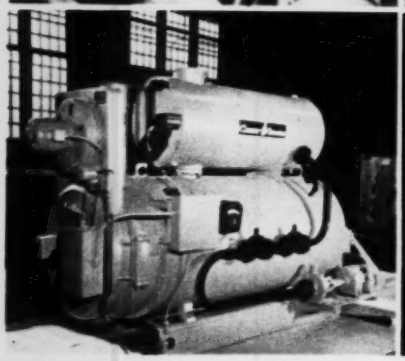

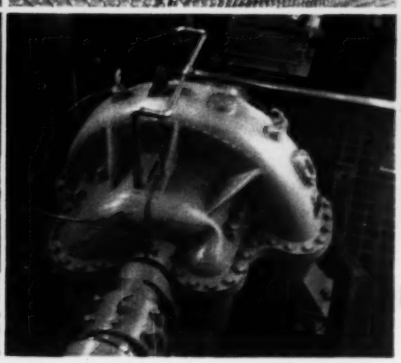

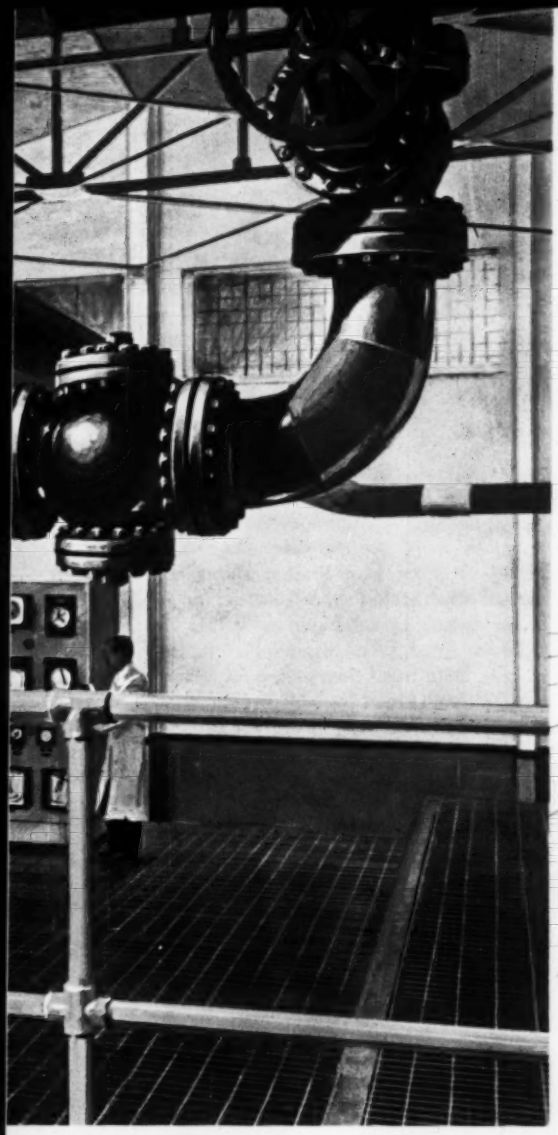

Rust-Oleum

NEW COLOR HORIZONS

System

HERE is a modern, functional *system* that combines four important points. (1) the ability to stop rust, (2) modern color harmony, (3) durability to last and last, (4) ease of application. From machinery, equipment, and structural steel to tanks, steel fences and metal sash – the Rust-Oleum New Color Horizons System can provide lasting beauty in the colors of your choice. Ask your Rust-Oleum Industrial Distributor, together with your Rust-Oleum Factory Specialist, to make a survey of your plant and provide complete recommendations. Rust-Oleum Industrial Distributors maintain complete stocks for prompt delivery in all principal cities of the United States, Canada, and in many countries around the world.

Rust-Oleum, in its various forms, can also save you time and money on problems like these: Heat Resistance, Water Resistance, Chemical Resistance, Coating Galvanized Metal, Speedy-Dry Coatings (less than thirty minutes to dry).

PROVED THROUGHOUT INDUSTRY FOR OVER THIRTY-FIVE YEARS

RUST-OLEUM®

See our catalog in Sweet's.

STOP RUST by applying Rust-Oleum 769 Damp-Proof Red Primer directly over the sound rusted surface

Save time, money, and metal. Brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining sound rusted surface after scraping and wirebrushing to remove rust scale and loose rust. **Specially-processed** fish oil vehicle penetrates rust to bare metal as proved in radioactive tracing studies.

STOPS RUST!®

Distinctive as your own fingerprint. There are imitations, but only one Rust-Oleum.

Insist upon industry-proved Rust-Oleum. Accept no substitute.

You take the brush! Try a free test sample!

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2985 Oakton Street • Evanston, Illinois

At no cost or obligation, please send me:

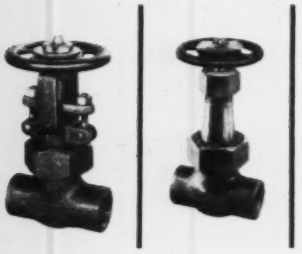
- ☐ New full-color catalog on New Color Horizons System and specialized Rust-Oleum systems, including color charts and applications.
- ☐ FREE TEST SAMPLE of Rust-Oleum 769 Damp-Proof Red Primer.
- ☐ Please have your representative contact us to discuss a plant survey.

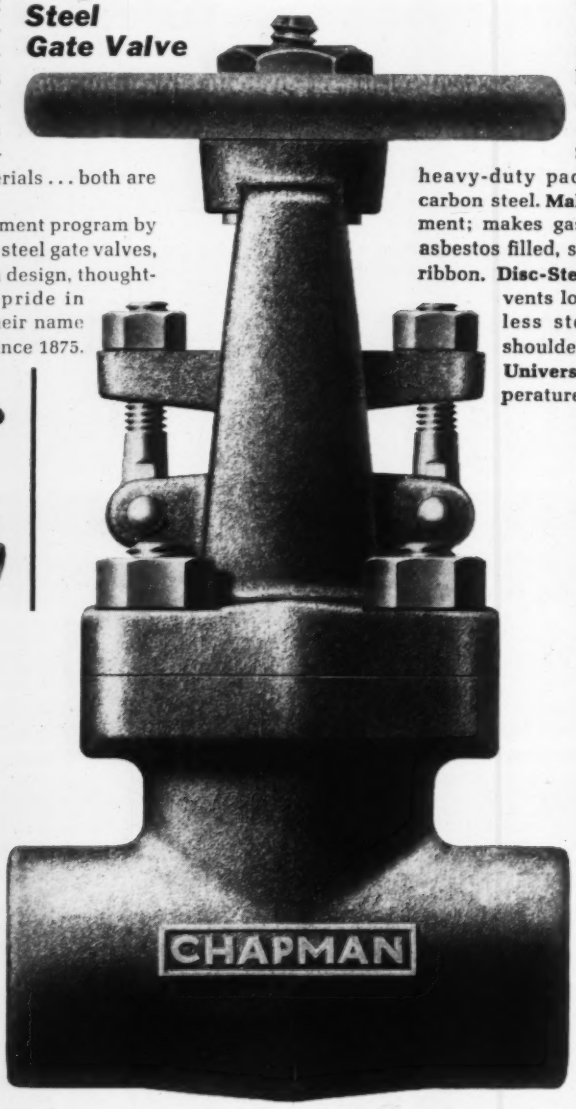
ENGINEERED TO "TAKE CARE OF ITSELF"...

New Chapman 960B Rugged-Duty Forged Steel Gate Valve

In valves, "forgetability" is a true measure of worth. "Forgetability" is defined in terms of those qualities which allow a valve, once installed, to be almost forgotten. It results from perfection of performance, and year-after-year dependability; combined with less than moderate maintenance requirements. These characteristics are the outgrowth of knowledgeable design and excellence of materials . . . both are tradition with Chapman Valves.

Product of an all-inclusive development program by Chapman, the *originators* of forged steel gate valves, the 960B represents the integrity in design, thoughtful selection of materials, and pride in workmanship which have made their name synonymous with quality valves since 1875.





Wheel . . . cast ductile iron. **Stem** . . . heat-treated stainless steel; backseats in bonnet. **Yoke Sleeve** . . . corrosion resistant Chapman alloy CV510. **Follower and Gland** . . . socket and ball type: bind-proof follower; stainless steel gland. **Eyebolts** . . . stainless steel; swing-down design. **Yoke** . . . "bowlegged" design for exceptional hand room. **Stuffing Box** . . . bigger, with special, heavy-duty packing **Bonnet and Body** . . . forged carbon steel. **Male-Female Joint** . . . for precise alignment; makes gasket blowout impossible. **Gasket** . . . asbestos filled, spiral-wound, flexible stainless steel ribbon. **Disc-Stem Connection** . . . sliding joint prevents load transfer. **Disc** . . . hardened stainless steel; guided travel. **Seat Rings** . . . shoulder type, Stellite-faced stainless steel. **Universal Trim** . . . all standard services; temperatures to 1000°F; pressures to 2000 psi.

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MECHANICAL ENGINEERING

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More Liberal Education in Engineering?

"Can the engineer perform the larger functions of industrial management, government policy making, and public leadership—which are increasingly his lot, whether he wills it or not—unless his education is much broader than that represented in the more technically oriented institutions?" This was one of the basic questions hurled at today's engineering colleges in a study made by the Institute of Higher Education of Teachers College, Columbia University. Entitled "Liberal Education and Engineering," the 132-page report was prepared under a grant from the Carnegie Corporation of New York.

In attempting to answer this and many other questions dealing with the place of liberal arts in engineering education, the study should stimulate the thinking of engineering educators. At the same time, it is designed to assist them in planning more adequate programs to fulfill our emerging national needs and purposes.

For example, the report notes that half the engineering schools in the United States should "substantially increase" the time they allot to the social sciences and humanities.

On the average, about one fifth of the four-year curriculums of these schools is devoted to the liberal arts. The report recommends that liberal studies should comprise at least a third of today's curriculums.

Beside giving an excellent historical treatment to the place of liberal-arts instruction in American higher education—engineering in particular—the report thoroughly reviews present practices. It also summarizes contemporary issues and presents certain suggestions for their solution.

Here, in brief, are some of the report's major findings and conclusions:

- All engineering schools should provide students with a "broad knowledge of the major areas of learning."
- Responding to pressures of a "utilitarian society" to keep their programs "practical," engineering schools have allowed their courses to become less theoretical than they could have been and "certainly more narrowly professional than they should be."
- Although there is growing interest in the liberal arts by engineering schools, less time is actually being given to these subjects. Result: A great variety of liberal-arts programs in the schools, each rigidly committed to a single approach in organization and content.
- Engineering faculty members are less favorably inclined toward liberal-arts education than their own administrators. Negative attitudes were found to have a decided influence on the views and motivation of students.
- Student counciling is doing little to promote a more liberal education for engineers—in some instances, it has the opposite effect.
- National societies—the American Society for Engineering Education, for example—have played influential roles in attempts to increase the breadth of engineering education. Recent revisions in the accreditation criteria of Engineers' Council for Professional Development hold out a firm promise of significant increases in the quantity and quality of instruction in the humanities and social sciences in the schools which have lagged.

This study presents a tremendous challenge to engineering educators. How they meet this challenge will be of great significance in the quality of engineering education in the United States.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.

ENGINEERING UNITY

A Unity Plan and Organization in the engineering profession is the hope of all

A PROFESSIONAL MAN is one who has a special body of knowledge and training with respect to which he feels three obligations: First, to use it in the public interest; second, knowing that it is incomplete, to add to the total of our knowledge thereto; and third, to teach others with respect to this knowledge. Engineering qualifies as a profession.

There are some who say that a man qualifies as a professional man only when he also retains his independence of judgment, opinion, and action based upon truth as he sees it. With this none of us can take exception.

One might say that the foregoing are outwardly directed obligations, yet the professional man is an individual, with an individual's needs for:

1 Establishment and enforcement of engineering registration laws.
2 Recognition of himself and his profession.
3 Remuneration comparable to his contributions.
4 A voice in the affairs of his community and nation in matters affecting him as a professional man.

These are frequently grouped together and referred to as the "professional needs of the engineer."

The Technical Society

The engineer's first obligation is service. He does this primarily through his own work. This work may permit him to add to the total knowledge relating thereto, and often he can teach his associates as well. The technical society, however, is set up to aid and encourage him to make a record of the new things which he has been able to add to our knowledge; to provide a means to exchange this new knowledge with others, in turn stimulating them to add still further thereto, and thus still further generating more new knowledge and putting it in such form that it can be taught to a still wider circle of professional people. In addition, the technical societies promote and stimulate research into needed areas, propose and foster the adoption of codes and standards, which in turn facilitate the contributions which can be made.

Additionally, these societies provide a forum where independence of judgment can be voiced.

The rapidly developing ramifications, specializations, and divisions of technology have brought about an inevitable "splintering off" from the original technical societies by those specifically interested in the different kinds of engineering. This decentralization was necessary, of course, in order that those interested in each branch of the profession of engineering, as it was rapidly developing, could put the required concentration of effort on their particular branch. Thus what started out as a single Society of Civil Engineers as distinguished from the Military Engineers soon found those interested in mechanical, electrical, and mining engineering splitting off and forming separate societies. Later the chemicals felt that they required a separate society, and since then we have had a host of other engineering societies formed, despite the fact that the five Founder Societies have each striven to protect their own organizations by establishing many "professional divisions." ASME has, for example, 24 such divisions.

It has long been recognized that each of these societies have common areas of interest; first, in each other's technology (since rarely does a project or a man's work exist solely in one discipline) and, second, in education, since many of the basic bodies of knowledge are common or overlapping. Then later it became clear that to protect the public and the profession it would become necessary, as with the legal and the medical professions, to

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Contributed by the Intersociety Relations Committee of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

By Glenn B. Warren,[1] Past-President, The American Society of Mechanical Engineers

and ASME MEMBERS

for closer liaison among the fields and for increased professional stature

protect and insure the adequacy of the educational programs and degrees which were being given.

A Council or Federation

These needs called forth efforts to form an overriding council or federation for the purpose of looking after the common technical interests of the several societies. This has culminated in the organization known as the Engineers Joint Council, which consists of a federation of some 20 technical societies. This organization in reality consists of representatives of these several societies who, at the time of their appointment, were members of the governing boards of their respective societies. These representatives meet several times per year, and the business is also facilitated by more frequent meetings of an "executive committee." The EJC is supported financially by the member societies.

In general, one might say that the EJC has been effective in dealing with intersociety technical matters, has promoted international co-operation in this area, has represented the engineering profession in technical matters to the United States Government, has instituted broad studies for guidance of government bodies on "Water Policy," has undertaken to do so in connection with a proposal to establish a broad understanding of the transportational problems, and has recently established a broad study of the newly developing problems of science and technology.

EJC has recently undertaken to make the general public more aware of the importance of the engineer as compared to the developing and often exaggerated role of the scientist in the public eye. Also, steps have been taken during the past year to report regularly to the members of the constituent societies on what the EJC has been doing, and is planning to do. The communications of the EJC to the technical-society members have been less than adequate in the past, and as a result there has not been a good and a fair appreciation by the various members of these societies of the contributions which the EJC has been making and can make.

Educational Interests

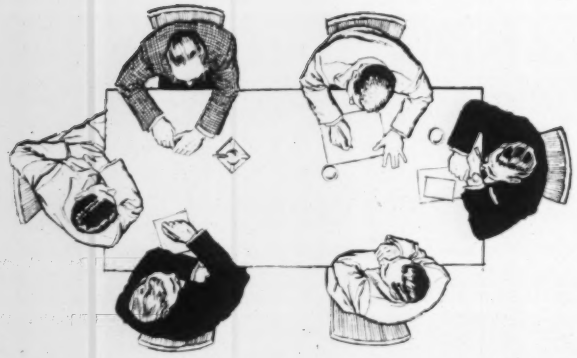
To meet the common educational interests of the engineering societies, the Engineers' Council for Professional Development (ECPD) was formed about 27 years ago. This body also has its members appointed by the governing boards of its eight constituent societies—that is, the five Founder societies plus the American Society for Engineering Education, the National Council of State Boards of Engineering Examiners, and the Engineering Institute of Canada. ECPD is generally recognized to have been outstandingly successful over the past two decades in establishing high standards for engineering education, in accrediting those curriculums in the engineering schools which conform to a sufficiently high standard, and in generally raising the standard of engineering education throughout the country.

In addition, they have set up a Code of Ethics for the Engineering Profession, and have developed programs aimed at helping the young engineering graduate through the difficult postgraduate period in his endeavor to become a competent and well-rounded engineer and citizen.

The "professional needs of the individual engineer" will be so called in what follows, to distinguish them from his needs in connection with common efforts in the technical or educational areas of his work.

Limitations Imposed on Us

All of the technical societies are organized under Federal and State laws which exempt organizations formed for the carrying on of scientific and educational activities from certain Federal and State income tax obligations, and from real estate tax, and which permit donations to them for capital purposes to be deducted



from individual and corporate income before tax. This has given important advantages, and has decreased the cost of membership and activities in these organizations, has promoted their growth, and has been in the public interest. This is known as a "501 C-3 tax status." Such organizations are prohibited by these laws from carrying on "any substantial part" of their activities in connection with attempts to improve the economic status of their members or of attempting to "influence legislation"—activities which are required if an organization is to meet important parts of the professional needs of its members.

However, an organization which does not wish to avail itself of all of these tax-exempt privileges can obtain a so-called "501 C-6 tax status" and is then free to carry on such activities. Although this has been the situation for a great many years, it is quite probable that most members of the technical societies have not been keenly aware of these limitations. This may have given rise to a feeling on the part of some members that the technical societies were failing to meet some of their obligations to them.

This then means that neither the technical societies, ECPD, nor EJC can in any appreciable manner meet the needs of their members in this professional area. It was with this in mind that a group, largely independently employed civil engineers or consulting engineers, set out in the early 1930's to organize an engineering society whose sole object would be to deal with these aspects of an engineer's needs. They accepted the then developing system of state registration of licensing of engineers as the criterion for membership, and organized the Professional Engineers Societies on a local, State, and National level. On the National level this has become the National Society of Professional Engineers (NSPE). They did not seek a preferred tax status, are organized as a "C-6" association, have their main office in Washington, D. C., with a staff of lawyers who continuously watch out for engineering interests in national and state legislatures. Through an elaborate committee organization, NSPE has frequent full Board-of-Directors meetings with representatives from all 50 State societies. More frequent meetings are held by an active executive committee, which keep a careful watch and organize for action in all areas of the engineers' professional interests.

While the NSPE membership was originally largely from the civil-engineering area, it is now somewhat difficult to determine the technical-society content of their membership because of multiple technical-society membership on the part of many of their members. Some information indicates that somewhat less than 50 per cent of the present NSPE membership are civils, and something less than 20 per cent are electricals and mechanicals, respectively, with the remainder scattered among the other disciplines. More than 75 per cent of their members belong to one or more of the technical engineering societies.

In recent years, more and more of the attention of the NSPE activities has been devoted to the problems of the engineer in industry. The growth of the NSPE has been remarkable, about twice the annual rate of the principal technical societies. A relatively small percentage of their members are of the Engineer-in-Training (EIT) category, but they have more than 50,000 full-member-grade members, almost as many of this grade as all of the Founder Societies put together.

As a result, the NSPE and the several State and local societies are so well organized at the national, State, and local levels, and are so completely recognized in the legislative bodies of the States and the Nation as speaking for these aspects of the engineers' interests, that most of those who have been giving thought to the further unifying of the engineering profession have felt that it was imperative to bring NSPE and the various State and local professional engineering societies into the unity organization to meet these needs of the engineers.

The Functional Concept

Studies of engineering unity since the 1930's have led to the development of a proposal which is now recognized as the "functional concept." Briefly, this was a plan which proposed that an agreement be reached by the constituent societies of EJC and ECPD, and, with the NSPE, that all intersociety matters pertaining to education and the setting up of engineering ethical principles be handled by ECPD; that all matters pertaining to intersociety technical matters be handled by EJC; and that all matters partaking of the economic, legislative, and enforcement of ethical-and-competency standards be handled by NSPE, that is, in this case, the so-called professional matters.

Agreement with this functional concept in principle was voted by the Council of the ASME shortly after it was proposed, and approval was given by the Board of Direction of the NSPE. In each of the years since, the ASME Regional Advisory Committees (RAC), and the subsequent Regional Delegates Conferences (RDC), have urged the Council of the ASME to implement this plan.

There were many, particularly in the ASME, who felt that the functional concept did not go far enough, and that there should be a co-ordinating council—to act perhaps as the "symbol and tangible expression" of unity within the profession, and also to act as a group to whom all who have reason to seek the authoritative expression of opinion of the engineering profession could appeal. It was also thought, as one engineer expressed it, that it might act as a "load-dispatching center." Another felt that this council, with representation from EJC, ECPD, and NSPE, might act as a continuing body to study means for a more effective unity in the future.

This whole question has been under intensive study by a Past-Presidents Task Force of the five Founder Societies since 1957, and also by the Intersociety Relations Committees of the ASME, the AIEE, and the NSPE, but so far with not completely satisfactory results.

The obvious question in the minds of the members of these several societies is, "Why haven't more complete steps toward these objectives been taken during this

time on a national basis?" particularly in view of the:

1 Co-operation between the several societies and NSPE in many areas on the local level.

2 Co-operation in the national programming and meetings areas by the holding of joint professional-divisions conferences and meetings.

3 Co-operation in the educational area by ECPD and the ASEE; and of course

4 Co-operation on the national and international level in the technical area through EJC.

What Holds Us Back

The reasons for the difficulties preventing more complete implementation of these unity plans are numerous, but the principal ones are as follows:

1 Fear on the part of some existing organizations of engineers that they may not be able to continue legitimate services for their own members, despite specific statements in the functional concept, and subsequent modifications of that plan, that the individual member societies could continue to exercise those functions for their own members which they have been doing.

2 Although mining or chemical engineers in private practice must be registered just as are engineers in other branches, few have had occasion or urgent need to become registered, and these societies have but few registered engineers in their membership. This has also led to a situation where few professional-engineer examinations contain questions specifically directed to the practice of chemical and mining engineering. This latter situation may be corrected by the societies taking the matter up with the State Boards of Registration. Here, also, the State Chapters of NSPE could be of assistance, but few chemical and mining engineers have full realization of the contributions which NSPE could make.

3 Another problem arises from the fact that many well-qualified engineers are not registered, and hence not eligible for membership in NSPE. (About 40 per cent of the engineering profession are now registered.) ASME and AIEE have both suggested that it would be desirable for NSPE to open its membership, for a restricted time, to qualified, mature, practicing but nonregistered, engineers so that NSPE could then more completely represent the engineering profession in this professional area. So far, no decision has been taken by NSPE in this matter, but it is now under active consideration and it is hoped that a favorable decision will result.

4 Until recently it has generally been felt that it would not be possible to implement any of these unity plans, and bring NSPE into the unity organization so formed, unless unanimous agreement on an organization set-up could be obtained by the five Founder Societies and NSPE. This unanimity has been impossible to obtain.

The Immediate Outlook

During 1960 the ASME Council and the Boards of the AIEE and the NSPE took steps, through their Inter-Society Relations Committees, toward seeking a basis for a simple unity organization which they could support, and then agreed to again seek the support of the other societies. They reaffirmed their feeling that the so-called functional concept would be basically satisfactory, and that it would be highly desirable to have a simple Co-ordinating Council to properly relate the operation of the three functions, and to serve as an "expression and symbol of Unity in the Profession." They reaffirmed their position that EJC, ECPD, and NSPE should be integrated into such an organization. But the most important step was a determination that, if unanimous agreement could not be obtained, partial implementation might be sought from those engineering societies which wished to join, in the hope that the difficulties in the way of more complete acceptance would gradually be worked out.

In spite of their being unable to agree completely on a unity plan, the Past-Presidents Task Force on Unity took a final action before dissolving their organization in which they recommended that the presidents and vice-presidents of EJC, ECPD, and NSPE meet together four times per year to better co-ordinate their work and avoid duplication of action and efforts. This proposal has met with general agreement, and meetings have begun.

The Member's Obligation

The practice of engineering seems to be developing a complexity and overlapping-of-disciplines which it never had before. Rarely is a practicing engineer working in one discipline only today. Many mechanical engineers work as members of teams with electrical, chemical, civil, mining, aeronautical, nuclear, industrial, rocket, or a score or more of other classifications of engineers. In fact, the mechanical engineer's work is basic to the success of most other types of engineering work, because he and his technology alone can clothe the other man's design with the hardware, the "bones and sinews" if you will, that will make it a working reality. This means that the mechanical engineer's full development and grasping of his opportunities may require him to keep abreast of, and to participate in, two or more disciplines, and he may need to belong to more than one technical society to do so effectively. Protection of and promotion of his "professional" interests require funds and his active participation and membership in the only society, namely, NSPE, which is definitely and legally set up so as to engage in such activities.

It may be of interest to examine the related situation in the legal and medical professions, since these two professions are more firmly fixed in the public mind and the legislative area than is the engineering profession. In both of these they have the professional society, respectively the American Bar Association and the American Medical Association, to which most of the members of the professions belong; but also they have numerous societies dealing with limited specific technical areas of their work. The annual payments to these several organizations appear to be from three to five or more times the annual dues to one of our technical engineering societies. It is believed that all of these costs are legitimate business cost deductions from income before taxes. As scientific and educational institutions, the technical societies dues are deductible on this basis as well.

The service which we get in all of these areas is apt to be pretty much in direct proportion to what we put in in time, effort, and money. A unity plan and organization in the engineering profession should make all of these intersociety efforts more effective, better co-ordinated, and more meaningful to the public and to the various government agencies involved. It will not be a substitute for the full participation and support by individual engineers of the technical societies concerned in their work, or of the local, State, and National professional engineering societies who are safeguarding and building up our professional interests and stature.

By L. F. Urwick,[1]
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THE ENGINEER'S

THE TOWNE LECTURE

When the study of management was in its infancy, ASME gave it a platform and a policy. The man behind this was Henry Robinson Towne, President of ASME in 1889. This Towne Lecture, delivered at the Winter Annual Meeting, is one of a series, the first of which was given by Herbert Hoover in 1925.

MANAGING is a practical art. Moreover, it is a practical art which is concerned at all times with human beings, the genus *homo*, so optimistically classified *sapiens*. And, if any lesson can be drawn from the only other practical art which has the same characteristic, namely, medicine, the growth of effective knowledge must be dependent on close and constant interrelations between research, theoretical teaching, and clinical experience. In the development of knowledge about management this intimate liaison has been lacking.

The late Professor Elton Mayo, a personal friend, has stated: "In the area of social skill there seems to be a wide gulf between those who exercise it—the actual administrators—and those who talk about it [1].[2] No continuous and direct contact with the social facts is contrived for the student... The equivalent of the clinic, or indeed of the laboratory, is still to seek [2]."

At the beginning of this century, the United States initiated a movement for education in management subjects which is without precedent in the history of education anywhere in the world. The rest of the world owes an immense debt of gratitude to this country: (*a*) For the vigor and optimism with which this tremendous teaching apparatus has been developed; (*b*) for the generosity with which, under plans for foreign aid, the results have been shared with students in other lands.

But, and it is a big "but," for the first 45 years of this development the initiative was almost exclusively academic. Business as such was indifferent or only mildly interested. It was not until approximately 1950 that any substantial proportion of the leading corporations began

[1] Lt. Col. Urwick, O.B.E., M.C., M.A., chairman of the board of Urwick Orr & Partners, Ltd., also delivered the 1952 Calvin W. Rice Lecture "about the other side of the looking glass." His topic was "Management's Debt to The Engineer," MECHANICAL ENGINEERING, vol. 75, 1953, pp. 374–379.

[2] Numbers in brackets designate References at end of paper.

Based on the Towne Lecture, presented at the Management Luncheon during the Winter Annual Meeting, New York, N. Y., November 27–December 2, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

DEBT TO MANAGEMENT

to regard executive development as a serious *business* responsibility [3].

In any event, so rapid a development of academic apparatus was bound to have weaknesses. It was likely, in the absence of continuous contact with practice, to suffer from what the French call *deformation professionelle*. The occupational hazards of the academic calling are, of course, well known. They include writing books about other people's books; a preference for the abstract rather than the concrete; inky warfare between disciplines; and a conviction that knowledge for its own sake should be the only legitimate business of a university.

In particular, the terminology of the subject is in a pathetic confusion. The word "management" itself is employed in a round dozen of different meanings. And many writers seem dedicated to the proposition that words of one or two syllables are "simple," in the clinical sense of the term. They should, in all circumstances, be avoided, but particularly if a word of six or seven syllables can be found to do the same job. And this is important. In the words of another old friend, Prof. J. B. S. Haldane, "Mechanics became a science when physicists had decided what they meant by such words as weight, velocity, and force, *but not till then* [4]."

The Role of the University

It is not therefore surprising that recently there has been some concern in this country about management education. Last year, two of the most distinguished private foundations issued reports on the subject [5]. In many respects these reports are frankly critical. But being written by academic people they do not appear to the author to go to the root of the matter. That traces back to the remark about knowledge for its own sake being the only legitimate business of a university. Should it be? Personally, the author would put a large, fat, emphatic question mark against that assumption. Of course, knowledge for its own sake, safeguarding intellectual values, is *part* of the business of a university. But it should only be a part and, probably, not the greatest part of a university's function. The main and principal business of a university is to teach. But what?

The Spanish philospher, the late Ortega y Gasset, suggested that much of the intellectual confusion in which Western civilization finds itself today is due to the fact that the universities have abandoned their historic role, which was the transmission of culture. For it they have substituted: (*a*) The teaching of the learned professions; (*b*) scientific research and the preparation of future investigators [6].

By "culture," Ortega y Gasset did not mean any kind of decoration...a couple of courses in Elizabethan poetry and two more in musical appreciation (as if they were different subjects!). He meant the system of ideas which are vital to us, by which we live. That system of ideas is drawn from the great cultural disciplines of our time, particularly physics, biology, history, sociology, and philosophy [7].

Business Adds to the Confusion

Business itself has contributed to this confusion. In a remarkable article on "The Quality of Leadership [8]" Cameron Hawley, author of "Executive Suite," suggests that you cannot train leaders "by handling them as though they were entrants in a perpetual popularity contest." Nor, he adds, can you develop leaders "in the atmosphere of a company where individual accomplishment—the only source of real and lasting personal satisfaction—is sacrificed for the fuzzy goal of one big, happy family. A healthy corporation must be a *business* institution—not a *social* institution devoted to the all-out pursuit of mass happiness [9]." You cannot man great business organizations by breeding "organization men." Any fool can employ ten men to make one man's decisions for him. That is the root principle underlying "Parkinson's law."

Not only has education gotten off the beam by substituting specialization for culture. Business, too, has tended to overlook the prime requirement of training for

future leadership, the early introduction of the promising entrant to over-all, as contrasted with specialized, responsibility. Ultimately, that is what leadership involves, the development of the specialist into the generalist. Some English friends state that there is no such word in the dictionary as generalist. As far as the 2500-odd pages of the "Shorter Oxford Dictionary" are concerned, they are right [10]. But the armies of the world have a well-established term, a General. That means in effect an officer capable of commanding a formation of all arms and services, of co-ordinating specialists. Generalist would seem to be a useful word to express the same quality without introducing undesirable connotations of status.

How Does the Engineer Fit In?

How does the engineer fit into this picture? It is suggested, with all respect, that he has been fortunate. In the early decades of this century he was virtually the only person in business, with the exception of a few lawyers and accountants, who had, in general, the advantage of intellectual development based on a higher education of a systematic kind. Because he was available and had "knowledge of acquaintance" with the business world and the techniques of production, he tended to qualify for managerial positions. And this practice was reinforced by the earlier development of the scientific-management movement which insisted that an intelligent approach to management problems must be based on a scientific education. In fact, he was promoted, not because an engineering education is necessarily the best kind of education for management, but because he was the only man available who combined knowledge of acquaintance with the situation and a higher education of any kind. And this tendency was an obstacle to thought. Business did not face the more fundamental inquiries: (a) What forms of education and early training *are* best designed to produce future leaders? (*b*) How can the educational and business systems be so adapted that a sufficient number of young entrants receive those forms of education and training before they are, say, 30 years old?

As a result, the whole attack on this vital problem has become distorted by attempts to tack onto established systems what exeprience has shown that they have lacked. The Wickenden Report suggested in 1930:

"The engineer of tomorrow will not rise to leadership by abandoning his distinctive role or by permitting it to become ill-defined. He will do so by remaining essentially an engineer, by becoming a more competent engineer, by extending the reach of engineering methods and ideals to larger realms of life, and withal, by making himself a team-mate eagerly desired by other types of men. If engineering education is to serve these ends, it must safeguard all the distinctive qualities and virtues of its past and add to them a more generous humanism [11]."

Fine writing! The writer himself has quoted the passage with approval. But what does it add up to? Let us not disturb the engineering educational establishment. Let us keep all we've got, but tack on to the crowded five years of a specialized curriculum "a more generous humanism." How?

More recently, a few of your greatest corporations have deliberately taken men out of business for six months or more in their late 20's or early 30's—for what [12]? In order to give them a liberal education, to add that humanism which their education had lacked. Most necessary and desirable, *if* their education has been too narrowly specialized on skills which will equip them to gain a first appointment. But surely the fact that it is necessary or desirable to do this is a bad case of putting the educational cart in front of the horse.

If the word university means anything, surely it means an institution where the young should be *introduced* to the universe of learning, an institution which the student should leave equipped, not with all the knowledge he will need—that is impossible—but with the interest and capacity for study to continue his own education, to identify and secure for himself the further knowledge that he will need if he is to live successfully in the technological revolution of our day.

You cannot manage *people* successfully by "tacking on" to the main body of business management a specialization called Personnel Management or Human Relations. The only kind of dealing with people which is really effective is a concern for them which derives from and is integrated with the control of the work itself, the purpose for which the undertaking exists [13].

Integrated Leadership Development

The same principle applies to developing future leaders. It must be an integrated process. You cannot *start* by educating a man to be a professional specialist and hope that, "by guess or by God," he will develop into a generalist. Educational systems must be revised so that men go out into life from the universities, equipped not merely to get a job, but to live "at the height of their times [14]."

The writer cannot pretend to tell you exactly how this is to be done. It is essentially a pedagogic problem. But the universities are not thinking about it. They are enmeshed in a labyrinth of specializations. For the professor "the nobleness of life," as Anthony said when he kissed Cleopatra, is to be one of half a dozen people in the world who know more about some tiny island of a subject than anyone else. Thus he becomes an "authority" and his books are reviewed in learned journals by the other five. Hence the emphasis on research. The ideal of a university, of the continent of learning, has been abandoned. Archipelagoes of warring disciplines have been substituted.

There is one curious piece of evidence that the writer

DEBT TO MANAGEMENT

may be on the right line. With the invitation from ASME to contribute to the current review of Ten Years' Progress in Management there was a bundle of letters from many eminent contributors. Among them was one from Peter Drucker. He expressed the view that the one book on management of conspicuous originality and quality published during the past decade was Peter Woodruff's two-volume "The Men Who Ruled India [15]." It is a memorial history, told in incidents, of the British Indian Civil Service. Drucker was the second leading teacher of management in this country to express this view to the writer.

Now one of *the* principal sources of British candidates for that service in the last half of the past century was Baliol College, Oxford, particularly Baliol when Benjamin Jowett was senior tutor and subsequently Master. And many of those candidates read "Literae Humaniores" or "greats" . . . Greek and Latin, Greek and Roman history, and philosophy. Moreover Jowett, as his biographer has recorded, took the view "that education, not research, was the first and final function of a tutor. Research, he seems to have thought, was more often than not a self-indulgence, an agreeable escape from more urgent, if more tedious, duties. If it was other than that for some exceptional teachers, if a room in a tower was essential to them, then they should make the kind of sacrifice in order to work in it and return to it that he himself made throughout his life [16]. It was wrong to use public money to make their choice easy. If teaching was their function they must put their pupils first and do their research in their spare time [17]."

Tackling The Problem

Why, if the writer cannot tell you how it is to be done, should he have ventured to table the problem, above all in a meeting of engineers, who are *the* professional specialists of our modern age? For four reasons. First, because many engineers have become managers, they are aware of their limitations. Second, because this Society was the cradle of management knowledge in these United States. Third, this talk is in honor of Henry Robinson Towne who told the ASME three quarters of a century ago [18] that the engineer who would become a manager must also be an economist. If he were with us today, he would expand that thesis. He would point out that the manager must also be a biologist, a sociologist, and a philosopher with some appreciation of human history. Fourth, because you are *practical* engineers, you know from your own experience that, however refined your skills and however deep your learning, they are so much water over the dam without the direction that integrates them with other skills, that makes of a corporation of 10,000 or 50,000 souls not a chance huddle of individuals, but a "team."

The first principle in all developments of human knowledge is to ask the right questions. And this question of how to develop future leaders in business seems to be *the* problem of our time. In two world wars millions of young men have laid down their lives for an idea, but the writer has yet to meet the young man who will lay down his life for a salary check. It is a problem then much wider than merely supplying the managers which the business corporations of this and other countries will need to carry on profitably. It is the problem of finding the quality of leadership which will convince the citizens of the free world that freedom itself is something worth working and living and, if necessary, dying for.

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14 Ortega y Gasset, op. cit., p. 46.

15 Philip Woodruff, "The Men Who Ruled India," vol. 1, "The Founders," vol. 2, "The Guardians," Jonathan Cape, London, England, 1953–1954.

16 Jowett never married.

17 Geoffrey Faber, "Jowett—A Portrait With Background," Faber & Faber, Ltd., London, England, 1957, p. 43. Jowett was elected to a fellowship at Baliol in 1838, appointed tutor in 1840, and Master in 1870. He died in the Mastership in 1893.

18 Apart from *Trans. ASME*, vol. 7, 1886, pp. 428–432, Towne's paper has been reprinted in "Classics in Management," ed. by Harwood F. Merrill, American Management Association, New York, N. Y., 1960, pp. 58–64.

By Joseph W. Lindsey, Assoc. Mem. ASME, Advanced

NOZZLE

Fig. 1 The commonly designed solid - fuel rocket case is a strong, light - weight cylindrical pressure vessel with elliptical or semielliptical domes at either end. Sound from the containment standpoint, the ability to direct the internal flow of gases so as to incur minimum flow losses and minimum erosion because of uneven flow distribution is questionable.

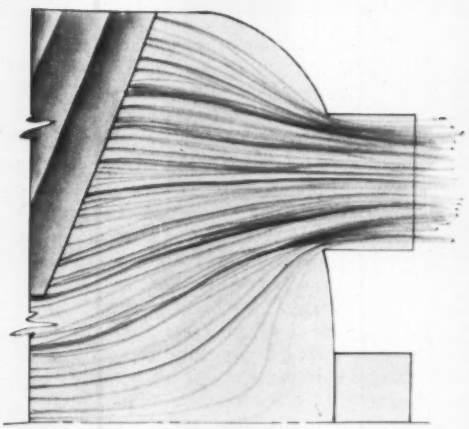

Fig. 2 In the present aft-closure four-nozzle-rocket design, the gases follow a somewhat Z-shaped path. In theory, the gases impinge upon the blast - tube entry corner nearest the center of the case, then separate and reattach themselves to the blast-tube wall causing severe erosion at the points of impingement and reattachment.

We solve these problems, working against time. But there must be a follow-up program to

In order for missile manufacturers, and therefore the United States, to compete successfully in the missile race it is imperative that design problems be solved by the quickest, most direct method that is possible.

The method usually employed is that of conceiving several design configurations and testing each of these under full-scale static-firing conditions. Almost invariably this method leads to a satisfactory solution and does so usually with a considerable savings in time over a rigorous research program.

There are three serious disadvantages to this method, however, in that: (*a*) An excessively high cost is incurred; (*b*) there is no assurance that the solution obtained is anywhere close to an optimum solution; and (*c*) little is really learned about the actual processes involved, making it quite difficult to extend the results to later experiments. Both of the latter disadvantages show the need for a follow-up program to improve upon the trial-and-error design and to build up a fund of knowledge as a basis for future work.

This article deals with a follow-up of just such a trial-and-error development, namely, that of the gas flow within a four-nozzle, solid-fuel rocket. The average engineer has become more familiar with liquid flow than gas flow. This has had an unfortunate repercussion in internal ballistics, as the flow of gases within the case has been severely neglected and, when considered at all, has been given only slight importance.

It is common practice to design a solid-fuel rocket case from the standpoint of producing a strong, lightweight

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Condensed from a paper entitled "A Cold-Flow Study of Nozzle Feeding From a Four-Nozzle Rocket Case" reporting on experiments carried out at the University of Utah in partial fulfillment of the requirements for a BS in Mechanical Engineering. The paper won the Old Guard Prize for 1960. The Old Guard Prize is an engrossed certificate and $150 awarded annually to the winner of the National Contest of Student Members who have won the First Prize at each of the twelve Regional Student Conferences. The National Contest was held at the Summer Annual Meeting and Aviation Conference, Dallas, Texas, June 5–9, 1960, of The American Society of Mechanical Engineers.

Development Section, Hercules Powder Company, Bacchus, Utah

FEEDING ....from a Four-Nozzle Rocket Case

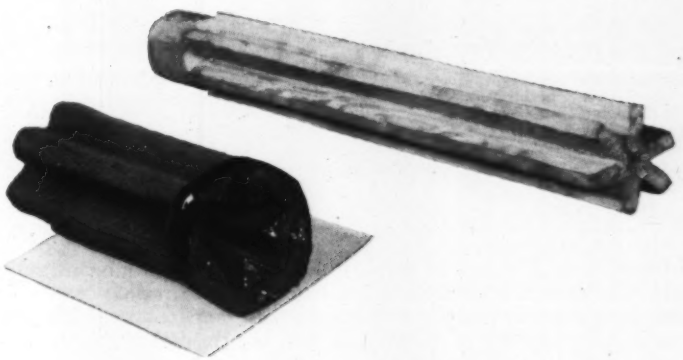


Fig. 3 A model for studying the flow of cool air was patterned after, but not scaled from, the first stage of the Minuteman. To originate air within the case in somewhat the same manner that gases are created in the full-size unit, a six-pointed wooden core was machined and wrapped with ordinary window screen. Air entering the case must find its way through the screen in order to travel up the center of the grain and then divide to leave the case.

build a basis for future work. This was such a study, on gas flow in a rocket's blast tubes.

pressure vessel by using a cylindrical body with elliptical or semielliptical domes at either end, Fig. 1. There is little question about the soundness of this design with respect to its ability to contain the required chamber pressure, but there is considerable question about its ability to direct the internal flow of gases in such a way as to incur minimum flow losses and minimum erosion due to uneven flow distribution.

The older solid-fuel rockets that employed a single nozzle presented relatively few flow problems since the feeding of a single nozzle at the end of a pipe was a well-understood process. However, the use of a single nozzle carried two serious penalties since: (*a*) The long nozzle must necessarily be quite long and heavy, and (*b*) a system of vernier rockets must be added to get some degree of guidance and control. The conception of short, accurate, silo-type missiles such as the Minuteman and the Polaris led missile designers to use four nozzles instead of one. This four-nozzle configuration did reduce length and provide complete control for roll, pitch, and yaw, but it was a venture into virgin territory where virtually nothing was known about the nature of the gas flow as it divides itself to leave the case through the four blast tubes.

The idealized flow pattern in the missile as it is designed today forces the gases near the center of the case to follow a somewhat Z-shaped path. This flow pattern can be seen in Fig. 2. Blast-tube and aft-closure failures in a four-nozzle rocket are often attributed to inadequate insulation in local areas. It is believed that the gases impinge upon the blast-tube entry corner nearest the center of the case, then separate and reattach themselves to the blast-tube wall causing severe erosion at the points of impingement and reattachment. This is usually solved by having an insulation task force cover the problem area with some "super" insulation. Another approach would be to redistribute the flow so as to do away with areas where the local velocity was very much higher than the average velocity. This would cause erosion to take place more evenly along the flow surface.

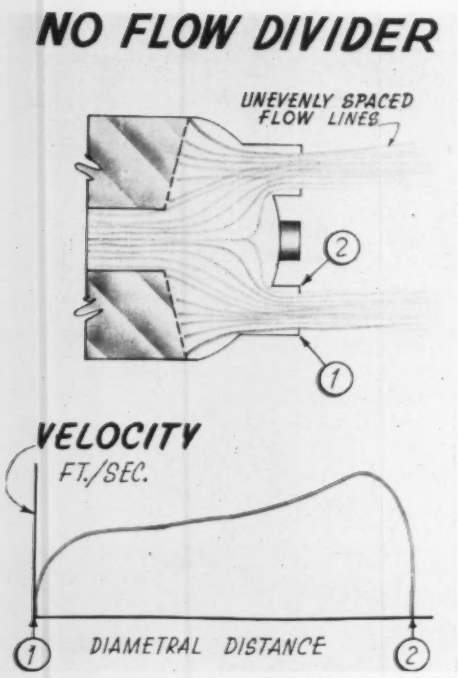


Fig. 4 The first investigation was made on the present design with no flow divider, and pressure traverses taken along a diameter from points 1 to 2 were converted to velocity profiles. On this and following Figs., diametral distance = traversed fraction of blast-tube diameter.

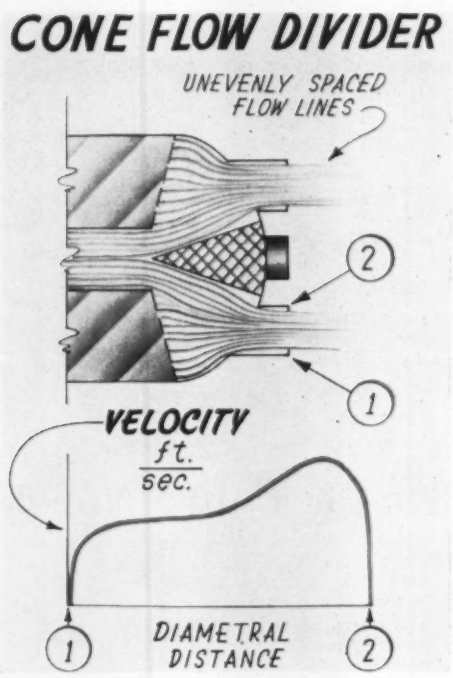


Fig. 5 Although a cone would seem to be the most logical flow divider, it produced a lower velocity at point 1 and a higher velocity at point 2 than the installation with no flow divider

Flow Distribution in the Blast Tubes

This study was carried out at the University of Utah as a bachelor's thesis project to determine the character of flow distribution in the blast tubes of the missile as it was designed up to that point. It was believed that the erosion problem could at least be partially solved by altering the internal geometry of the case to shift the flow patterns. This might be accomplished by placing the appropriate flow-dividing configuration in the aft closure between the blast tubes so that the gases were evenly directed in their exit from the case.

The method of study decided upon was that of forcing relatively cool air through a small model rocket, Fig. 3. This is called the cold-flow technique and was selected with the realization that such a study is limited to low-temperature, low-velocity air flow and completely ignores the problem of particle flow. It was felt, however, that if properly conducted the experiment would yield valuable information that could be used to at least establish the flow trends in a full-scale missile.

The model was designed by purchasing a 4-in-diam plastic cylinder and machining the components in reasonable proportions to this case dimension. To avoid violating national security regulations, the model was patterned after, but not scaled from, the first stage of the Minuteman. The only dimension taken from the actual missile was the ratio of major to minor diameter for the contour of the aft closure. Perhaps the most difficult job in constructing this model was that of originating air within the case in somewhat the same manner as gases are created in the full-size unit. This problem was successfully solved by machining a six-pointed wooden core and wrapping it with ordinary window screen. The forward end of this simulated propellant was then sealed off so that air entering the case must find its way through the screen in order to travel up the center of the grain and then divide to leave the case. Having constructed the model, it was then clamped to the bed of a discarded lathe and a pitot-static tube was mounted in the lathe carriage. The lathe adjustments then gave accurate control of the movements of the pitot-static tube in three planes of motion.

The air for the experiments was supplied by a two-stage compressor and fed to the model. Air flow was adjusted by means of a right-hand control valve just downstream from the compressor. With the flow rate arbitrarily set, the air passed into a flow chamber where pressure and temperature measurements were taken. A flow nozzle and manometer then established the flow rate before the air passed to the model. To minimize line-pressure variations as the compressor cycled on and off, it was kept running at full capacity by bleeding off the excess air with the left-hand control valve.

The first investigation was conducted on the present design with pressure traverses taken along a diameter from point 1 to point 2 (see Fig. 4) and converted to velocity profiles from point 1 to point 2 according to the formula[1] $V_0 = \left(\frac{2(P_s - P_0)}{\rho}\right)^{1/2}$. Velocity profiles were also plotted along a diameter perpendicular to that from point 1 to 2. This second set of profiles indicated

[1] Where V_0 = velocity, fps; P_s = stagnation pressure, lb per sq ft; P_0 = static pressure, lb per sq ft; ρ = density of air, slugs per cu ft.

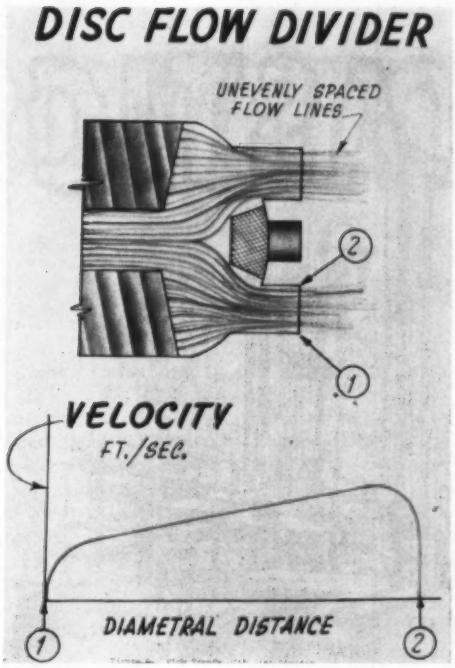


Fig. 6 When a flat-faced disk was substituted, the flow pattern proved to be quite similar to that for the design without a flow divider. There was a considerable loss in velocity head, believed to have been the result of high turbulence created by the disk.

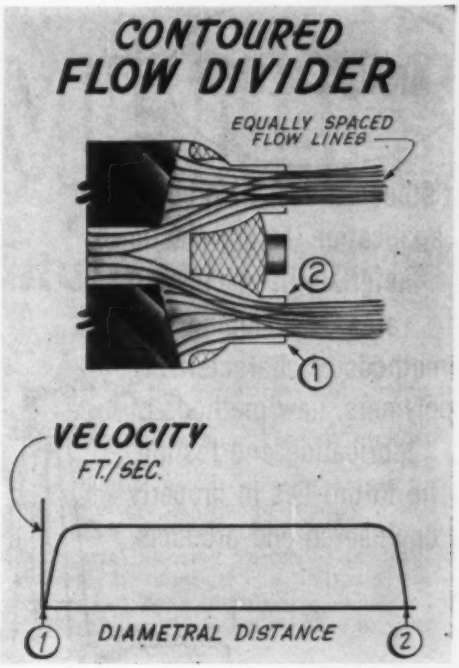


Fig. 7 The optimum contour found by trial-and-error testing proved to be a flat-faced center pedestal with inflections in the outside-wall contour. Radial webs between the blast tubes were an important feature of the optimum shape.

the flow to be evenly distributed along this diameter for all experiments conducted and therefore served only as a check on the experimental technique. The profiles were plotted at three different flow rates to show that the uneven profiles were a function of the internal geometry rather than flow rate. Variations in flow rate only served to shift the height of the respective curves. It was concluded that the proper flow divider placed between the blast tubes would yield a velocity profile that was symmetrical about the blast-tube center line.

Flow-Divider Variations

The most logical flow divider would seem to be a cone, but very interesting and contradictory patterns were produced by a cone as shown in Fig. 5. It was found that a cone produced a lower velocity at point 1 and a higher velocity at point 2 than with no flow divider at all. This indicates how the flow of gases in the rocket case cannot be readily predicted since a small change in geometry based on intuition may have large adverse effects on the flow field.

The next configuration tried was that of a flat-faced disk, Fig. 6. It was hoped that the flow impinging on the flat face would be thrown to the outside, thereby improving the symmetry of the flow pattern. Not only is the flow pattern quite similar to that in the present design, but also a considerable loss in velocity head is encountered. This head loss is believed to have been dissipated by the high turbulence created by the disk.

Following a technique developed in 1942 by K. D. McMahan and N. P. Bailey in the General Electric Research Laboratories, ordinary molding clay was placed in the aft closure and molded in such a way as to not only divide the flow but also to influence the velocity profile from both walls, rather than just from the center wall as with the other flow dividers. Experiments conducted by Mr. Bailey and Mr. McMahan support the use of a cold-flow study since they indicate that when the flow is straight when cold it will remain straight when hot; i.e., temperature has little effect on flow alignment.

Optimum Contour

After several days of trial-and-error testing, an optimum contour was found that produced an almost perfectly flat velocity profile. This flow divider is shown in Fig. 7. Notice the flat-faced center pedestal and the inflection point in the outside wall contour. Another important feature of this optimum shape is the presence of radial webs between the blast tubes.

Another facet of this study not presented here is that the six-pointed grain was located so a star point was directly in line with one blast tube while the tube adjacent had a grain point in line with it. Positioning the grain in this manner indicated the maximum difference in nozzle feeding due to grain misalignment.

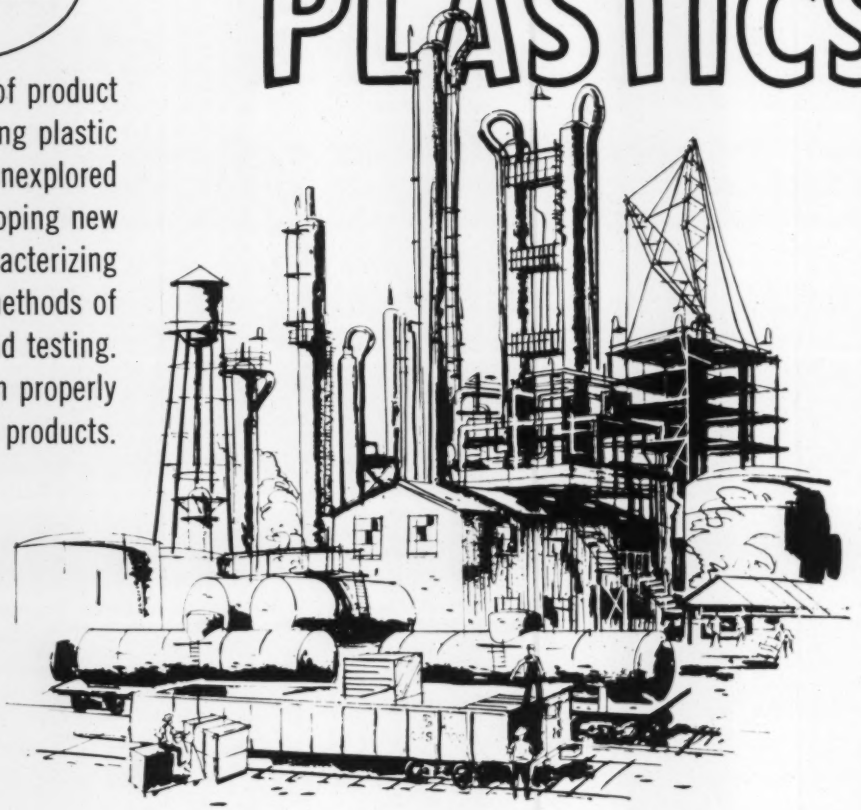
Summary

It is noted that these results are not conclusive since they have not been substantiated in full-scale tests. However, they do indicate the need for further tests of a similar nature and show the feasibility of a flow divider in the aft closure of four-nozzle rocket engines.

ANNUAL REVIEW

PLASTICS

It's been a year of product application, trying plastic materials in unexplored areas, developing new methods of characterizing polymers, new methods of fabrication and testing. The future lies in properly engineered end products.



By G. B. Jackson, H. G. Dikeman, and K. R. Nickolls,
Monsanto Chemical Co., Springfield, Mass.

THIS paper reviews those developments in the plastics industry which are judged to be of interest to the mechanical engineer. The 1958–1959 review was presented before the annual meeting of ASME last year and appeared in MECHANICAL ENGINEERING in March [1].[1]

An excellent review of engineering advances for 1959 was presented in the January, 1960, issue of *Modern Plastics* [2]. Other articles included a review of plastics materials in Canada with emphasis on application and fabrication [3] and a review of the industrial complex of Canada's plastic industry [4]. Basic polymer research, as well as the increase of specialized academic institutions to study polymers in Red China, was reported [5]. Several innovations in plastic application, processing, plant, and equipment were present at the International Plastics Exhibition [6]. A new book designed to provide basic technical information on the principal plastic materials, process equipment, and applications is available, and is valuable as a reference [7].

Materials

Major developments in the materials area were largely confined to application technology, with relatively minor modifications of existing polymers, and additions to major polymer families to render them useful in specific areas.

Acetals. "Delrin" is now in commercial production. A large percentage of this resin is expected to be used to replace expensive metals such as zinc, aluminum, and brass [8, 9].

Acrylics. A new book reviews acrylic resins and describes the four types—cast products, molding compounds, emulsion, and solution compounds—with respect to manufacture, fabrication, and applications [10]. Crystalline poly(methyl methacrylate) has been produced experimentally [11] and a new acrylic thermoplastic possessing good heat and weather resistance has been announced [12]. An acrylic polymer with higher level of crosslinking is claimed to enhance life of baking enamels [13]. The use of acrylic polymers as rigid PVC additives is cited as improving processability, with no sacrifice to key properties of the vinyl resin [14].

Epoxies. The growth of epoxy resins is expected to be

[1] Numbers in brackets designate References at end of paper.

Contributed by the Rubber and Plastics Division and presented at the Rubber and Plastics Conference, Erie, Pa., October 9–12, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

DEVELOPMENTS

A Review of the Literature for 1959-1960

much greater than that of the plastics industry as a whole [15]. Two new families of epoxy resins have been announced [16, 17], and laminating resins capable of producing preimpregnated stock with superior shelf life and high-temperature strength have been developed [18]. Several new curing agents [19] and a unique modifier system [20] have been announced for use with epoxy resins. The reinforcing action of glass and organic fibers in epoxy-resin laminates has been evaluated [21].

Polyethylene. Technology has been developed to improve crystalline pattern in film [22] and to alter property profile of molded articles [23] by combining high and low-density material. The development of copolymer technology has received major emphasis. Ethylene copolymers have broadened the market base for polyolefins through improvement in properties such as stress cracking, long-term load-bearing ability, stiffness, and impact resistance [24, 25, 26, 27].

Other material innovations expected to increase polyethylene use include: Chemically cross-linked polyethylene exhibiting several advantages in wire insulation and cable jacketing [28]; radiation cross-linked film for use as an oriented, shrinkable packaging film [29]; finely powdered polyethylene for use in coatings and large moldings [30]. A British publication reviews basic aspects of polyethylene production, properties, handling techniques, and major uses [31].

Fluorocarbons. A review of polymers containing fluorine lists major property advantages, special applications, and areas of future development [32]. Properties and intended applications for fluorinated ethylene-propylene which will be produced by du Pont are reviewed [33]; two articles review characteristics of new fluorocarbon elastomers, and include areas of potential application [34, 35].

Polyvinyl fluoride film which is transparent, flexible, and possesses excellent weatherability and chemical resistance is being produced [36]. A new tetrafluoroethylene resin-fiber blend has been developed to produce reinforced TFE resin possessing good cold-flow and ablation resistance, together with the chemical resistance and low friction of the TFE resin [37]. Fluorine chemistry is playing a major role in the development of new and better polymers for use under extremes of environment [38].

Phenolics. A book reviewing phenolic resins, primarily from an application viewpoint, has been published. This volume will serve as a source of information on the broader aspects of the versatility and complexity of phenolic resin applications [39].

Polyurethanes. A review of markets and applications indicates a phenomonal growth rate for urethane foams [40]. Developments include a special catalyst to cut one production step from continuous process of foam [41], the use of spray-foam application techniques [42], and the use of special blowing agents to produce low-*K*-factor foam [43]. Improvements in foam cushioning characteristics can be accomplished by using tertiary amine catalysts with 2-amino-ethoxy structure [44]. Details of several applications for solid urethanes, based on analysis of mechanical properties and environmental resistance, are reviewed [45].

Polypropylene. Comparative property data, application and market areas, and product advantages are reviewed [46, 47]. Polypropylene wax may find use in paper coating and as a modifier for other waxes [48]. Modifications of polypropylene through high-energy radiation [49] and chlorination [50] were investigated.

Polyesters. A technique to tailor-make polyester resins enables formation of linear polymers of any desired chain length [51]. Physical properties of reinforced auto bodies and boat hulls have been improved through clay-type fillers [52]. Interest in low-pressure reinforced plastics in structures [53] and flame-resistant laminates remains active [54]. A method for treating Mylar results in increased resistance to thermal embrittlement and hydrolysis [55]. A reference on polyester resins, including historic background, chemistry, applications, and characteristics of major resins has been published [56].

Polystyrene. The major efforts in the styrene area remain in the realm of copolymerization. These copolymers are finding increased acceptance in the industry in spite of strong competition from polyolefins [57].

Vinyls. The versatility of this family of resins is made possible largely through the use of select plasticizer systems [58]. New plasticizer systems have been designed to improve certain important properties of vinyl chloride-vinyl acetate copolymer [59]. The use of Ba-Cd complexes for light stabilization [60] and chemical cross-linking for improving film and fiber properties of vinyl polymers [61] have been investigated. Two review articles cover vinyl chloride polymers [62] and organosol formulations for stir-in dispersion-type resins [63].

Properties and Methods of Test

General. Work is continuing in independant laboratories, universities, and professional societies to develop more meaningful methods for characterizing polymeric materials. Advances took place in the area of high-speed testing [64], increased accuracy of Young's modulus measurements [65], improved apparatus for measuring

pliability (wrappability) [66], a new technique for determining second-order transition in thermosetting polymers [67], a new test for evaluating resiliency of flexible foams [68], a technique for relating orientation to properties of molded items [69], and a nondestructive quality control test for finished reinforced-plastic parts [70]. Reviews have been published on general physical test methods [71] and on the specific and troublesome areas of hardness, abrasion, and wear testing of plastics [72]. Work is progressing on upgrading the accuracy and reliability of polyethylene tests through studies on thermal-history effects on specimens [73], improved methods for brittleness temperature measurement [74], and investigations in stress-cracking [75] and stress rupture [76]. Melt-flow studies [77] are of particular interest; they relate directly to polymer processability.

Structural. As the plastics industry matures, the potential for polymers in applications requiring sound engineering-design parameters has become obvious. Considerable work in the area of structural design with plastics has been done, with emphasis on test methods, properties, and interpretation and utilization of data [78, 79]. A review of available data on major polymer families indicates need for more data and better dissemination of available information if the potential for plastics as engineering materials is to be realized [80]. Effort has been directed toward developing test techniques and data on load-time relationships of plastic materials. Stress-relaxation, creep, and fatigue-test technology have received substantial attention [81–92]; and failure mechanisms [93], and effects of stress concentrations [94] and stress risers [95] on the strength of glass-reinforced laminates have been investigated. An expression for the elastic behavior of a weak-core sandwich panel—initially warped, simply supported, and subjected to combined loadings—has been derived [96]. Techniques for predicting long-time performance of plastic pipe from short-time burst strength [97], and data on long-term behavior (creep rupture strength) of plastic pipe were reviewed [98].

Permanence. The behavior patterns of polymers in reacting to the total of their surroundings present an extremely complex area of investigation. This behavior commonly considered as degree of permanence, or resistance to aging, is most important. Several reviews in this area have been prepared [99–101]. Investigations related to permanence characteristics in specific environments include a study of polymer degradation by ultraviolet radiation [102], a new artificial-weathering method [103], the natural weathering of acrylic plastics in the tropics [104], thermal-aging techniques for PVC compounds [105], and effects of thermal environment on laminated plastics [106] and polyethylene [107]. The corrosion resistance of plastics makes them valuable for use in the chemical industry; however, much more information on this property is needed [108]. The resistance to chemical corrosion of polyester is reported for a five-year period [109]. The advantages of polyester for use with fluorinated refrigerants [110] and hot HCl fumes [111] are cited. The need for plastic materials possessing the ability to withstand elevated temperatures continued to receive attention [112, 113, 114]; epoxies [115, 116, 117] and polyesters [118] are being developed for these applications.

Ultrahigh Temperature and Ablation. Missiles and space vehicles have increased research efforts aimed at the development and evaluation of materials to withstand the extremes of environmental temperature encountered [119, 120, 121]. Ablation research on reinforced plastic materials was reported [122, 123, 124]. The use of new highly refined potassium titanite together with special thermosetting resins appears promising for space-age insulation problems [125].

Flame Resistance. The importance of flame resistance, particularly in building applications, has been brought to the fore as large markets are threatened by building codes and tests and standards which were developed for more conventional materials such as wood [126, 127]. Progress has been made in developing self-extinguishing plastics and methods of test for this characteristic [128, 129]. A tabulation, covering plastics that have passed ASTM and military specifications, has been published [130]; and a study has been made on gaseous combustion products from plastics [131].

Radiation. The effects of radiation on plastics were considered in several publications. A general treatment was presented in several articles [132, 133, 134, 135, 136, 137, 138] and more specific work was reported on gamma radiation of polystyrene and polymethyl methacrylate [139], polyalphamethyl styrene [140], polytetrafluoroethylene [141], low-pressure polyethylene [142, 143, 144], polyvinylchloride [145]. Radiation has been employed to copolymerize polystyrene and polyethylene, and to polymerize in-situ monomer impregnated wood [146]. Soviet news reports development of organic semiconductors by the irradiation of polymers [147].

Films. Work on the development of test methods and data for polymeric films included gas-transmission research [148, 149], oriented thermoplastic sheet and films [150], properties of nylon films [151], heat-shrinkable, polymer-coated polyester film [152], and a study of water-vapor absorption of unsupported films [153].

Processing

General. Commercially available processing equipment has been reviewed by the latest SPI Handbook [154]. The extensive Plastics Exhibitions at Hanover [155] and Düsseldorf [156, 157] highlighted many developments in molding, extruding, and forming. Two encyclopedias [158, 159] and two directories [160, 161] were issued to assist those seeking assistance in the selection of materials, machines, processors, and new end products.

Molding. Injection-molding machine capacity may be increased by improved nozzle mixing [162] and by reduced set-up time [163]. The mold-flow process which involves freezing of the melt as it progresses was studied, correlated [164, 165], and a spiral mold was used to correlate injection-molding-machine variables for the molding of polypropylene [166].

Special problems with the dry coloring of polypropy-

lene [167], molding of FEP-fluorocarbon resin [168], and with molded-in stresses in polyethylene [169] were discussed. New ideas for preplasticizers can improve homogeneity and increase capacity [170, 171]. Capacity with long cooling cycles can be increased by the use of 8 turret-mounted molds [172]. Insert-alloy selection is important to minimize stress cracking [173]. A simplified process for making injection moldings with internal threads was disclosed [174].

A check list which should be helpful for mainteance of injection molding equipment has been compiled [175].

The moldability and cure of thermosetting materials have been investigated to determine suitable molding conditions [176]. The properties as influenced by curing conditions [177], and cure as influenced by molding conditions, part design, and mold design have been correlated graphically with molding properties [178].

Developments in rotary molding of thermosetting materials [179], comparative data on new compression and transfer-molding machines, and auxiliary equipment have been listed [180, 181]. VHF preheating for thermosetting molding materials has been reported to reduce cost and improve quality of molded parts [182]. Multicavity molds utilizing centrifugal forces can be used economically to cast epoxy resins for small parts with metal inserts [183]. Seven of the fifteen available processes for molding fiberglass-reinforced plastic parts have been discussed critically [184]. The effects of molding variables on properties of glass-polyester molded parts have been discussed [185]. Polyester premix molded parts can be substituted advantageously for metal in housings, pump parts, and appliance frames [186]. A graphical method of controlling the cure of polyester resins related gel time to formulation, air temperature, and relative humidity [187]. Current practices for encapsulation of electrical components with alkyds were described [188]. Plastic patterns have been used to cast one-inch dimension parts (with close tolerances) in quantities of over 25,000 [189].

The commercial availability of more rigid polyethylene and polypropylene has brought a plethora of papers in the important field of blow molding. Penetration of four to five per cent of the two-billion can market, and 15 to 20 per cent of the 20-million bottle market is predicted [190]. The versatility and economy of blow molding for production of a large variety of toys, housewares, automotive parts, and industrial components have been illustrated with many examples [191].

Analyses of equipment, cycle time, mold design, and related economics have been made [192, 190, 193]. Three directories list American and foreign suppliers, together with typical equipment specifications [194, 195, 196]. Novel techniques for the continuous forming by blow molding from extruded tubing, of articles having length-diameter cyclic dimensions [197], and the use of a standard 8-oz injection molding machine for blow molding of bottles at reasonable production rates, have been described [198]. A detailed analysis was given for a two-bottle mold, including equipment design, operation, capacity, and product quality [199]. Cellulose acetate and propionate have been used to blow mold objects with high stiffness and transparency [200]. The thermoforming of thermoplastic sheet has been carried out continuously to form relatively deep small "pockets" in the sheet [201], and two new machines have been described for production of deep-drawn plastics packages [202]. A directory of thermoforming machines was published [203].

Innovations in mold construction and design to achieve increased capacity and economy include: The use of high-thermal-conductivity designs [204]; furnace brazing of cooling cores [205]; insulation of nozzles and runners [205, 206]; the use of chrome plate, vapor honing, sand blasting, die engraving, photo-arc engraving [207]; electro forming [208]; and the specification of the radius of curvature of bends [209]. The fully automatic insertion of metal parts has been accomplished by novel mold design [210]. Mold design for polyester premix was discussed [211]. Epoxies have been applied for facing drop-hammer dies used for forming sheet-aluminum aircraft parts [212].

The elements of successful design for thermoforming linear polyethylene were discussed in terms of materials, channeling, contouring, surface finish, and shrinkage [213].

Extrusion. An extrusion bibliography with 144 references [214] indicated that many aspects of the extrusion process are rapidly outgrowing the "art" stage. New interpretations of flow-stream lines in an idealized extruder channel have been prepared [215]. A detailed analysis of pressure development in extruder screws has been made, and it is shown to affect capacity and product quality in an important way [216]. Examples of the performance of high-speed extruders up to $2^1/_2$-in. diam were given [217]. A detailed analysis of idealized extrusion models for isothermal, pseudoplastic [218], and for nonisothermal steady-state non-Newtonian flow, together with velocity and temperature profiles based upon computer calculations [219], is available.

Novel extrusion developments include an extruder in which granules were melted on a rotating heated disk and taken up on a screw [220], and one in which melting and pumping were accomplished by a disk-shaped rotor with close tolerances to a facing stator. Pulsation-free homogenization and degassing were demonstrated [221]. The use of vacuum in the extruder feed hopper to reduce porosity of the extrudate [222], and a novel four-pump, extruder combination for a multi-product extrusion process were described [223].

High density polyethylene has been extruded and formed into complex profiles with close tolerances [224]. Extrusion casting of Nylon 6 has been used for large propellers, gears, wheels, slabs, hinge stones, etc. [225]. Plastic melts have been conveyed from an extruder through a flexible conduit for use in welding operations [226]. The formulation and extrusion of peroxide cross-linked polyethylene were discussed in detail to obtain a wide range of rubberlike properties [227]. Expandable polystyrene has been blow extruded to form film of 4–35 lb per cu ft density. The foam when laminated to impact polystyrene is useful for display signs and shallow trays [228].

A directory of extrusion machines [229] and a helpful

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set of operating instructions and maintenance tips are available [230].

Film. The product-quality advantages of the "water bath" and "chill-roll" film extrusion techniques for polypropylene were correlated, based on factorial experiments with processing variables [231]. Separate studies were also made with polypropylene using the chill-roll process [232], and with polyethylene using the water-quench film process at speeds up to 440 fpm [233]. Design requirements have been given for producing $^1/_2$ mil unplasticized PVC film by the blow-extrusion process [234]. The clarity of polyethylene film has been improved by annealing prior to blowing the extruded tube [235]. Formulation, compounding, and calendering of rigid PVC sheets were discussed in general terms [236]. Characteristics and behavior of multiaxially stretched polyethylene and polypropylene film were reported; test procedures were given [237].

Other. A novel process for production of large moldings, with no expensive tooling or presses, involved the fusion of powdered polymer on the surface of a metal mold, followed by heat smoothing and cooling; the finished part was then stripped from the mold [238]. Cellulose acetate butyrate coatings have been deposited on irregular objects by fluid-bed techniques. Corrosion resistance with various materials was given [239]. Optimum processing conditions for coating metal objects with PVC via a powder process were described [240].

A novel process for coating liquids with liquids to encapsulate a variety of materials with substantially any viscous polymer system [241] was described. The overwrapping properties of polyethylene film were studied with ideal and nonideal machine-design conditions [242].

A new instrument design to measure static charge on moving plastic materials, and techniques for elimination of static problems were suggested [243]. Building layout and equipment costs for electron-beam wire irradiation were discussed [244]. Control-valve design procedures for viscous pseudoplastic fluids are now available [245]. Polyurethane foams have been produced in place for insulation of tanks, ships, and processing equipment [246]. A discussion of the cost, strength, and thermal and cushioning properties of molded polystyrene foam was given [247].

Post-Treatment Fabricating Techniques. Post-treatment processes included sawing [248], cutting, deburring, deflashing, polishing, and increasing luster of thermoplastics by tumbling [249], punching, sawing, threading, drilling, tapping, etc., of paper, cloth, and glass-reinforced laminates [250], automatic buffing and polishing of lacquered surfaces [251], and machine welding of PVC and polyethylene [252]. Machining, welding, and joining techniques for acetal resins [253], welding and stamping of sheeting [254, 256], a new hand tool for high-speed welding [255] and heat sealing and high-frequency welding [257] were discussed. Calculations of two-dimensional temperature fields in the heat sealing of thermoplastic sheeting were carried out, with examples of computer results [258].

Electrical-discharge treatment improved adherability of the surface of polyethylene film [259]. Polyethylene film has been embossed and perforated to minimize suffocation hazards [260]. Film has been treated with elemental fluorine gas for special permeability properties with nonpolar liquids [261] and with vacuum metalizing to achieve special appearance effects [262].

Processing Properties. The increasing ability to use "scientific" techniques for the design and development of new equipment was accompanied (happily) by an increase in the literature describing processing properties of polymers.

Novel techniques for rapid measurement of heat capacity of polymer films, powders, etc., as a function of temperature gave information on the mechanical state of the polymer [263, 264]. Heat-capacity information was given for the following: polyethylene from 0 to 250 C [265], polypropylene from 0 to 300 C [266], and polystyrene, polypropylene, and epoxide polymers from 30 to 160 C [267]. The important case of unsteady-state freezing of slabs and cylinders was considered for variable heat capacity; calculations of melting and freezing rates for crystalline polymers were carried out, and computer results were fitted to simple equations [268].

A paper has been published on the flow properties of vinyl resin plastisols [269]. Other rheology articles included correlation techniques and useful applications in polymer processes for melt-fracture phenomena [270], a visual study of flow patterns at the entrance of a capillary with polyethylene [271], a survey of steady flow and dynamic rheometers with quantitative comparison [272], a study of variables which affect flow irregularities of polyethylene capillary extrusion [273]. A critical study of steady-state flow, extrudate irregularities, and normal stresses for polymer melts was published [274]. New data were given for the effect of hydrostatic pressure on melt viscosity [275], and a new flow parameter, the melt-index equivalent, has been proposed for quality-control testing of polyethylene [276].

At lower temperatures, studies have been made on the dynamic behavior of rigid PVC at minus 30 C to plus 50 C [277]. A broad range of polymer properties, including diffusional, mechanical, and electrical over a wide range of conditions, was discussed in a series of 20 papers in book form based upon a University of London symposium [278]. A new book which emphasizes stress-relaxation as interpreted by viscoelastic theory and basic physical properties of polymers was published [279]. The mechanism of cold drawing of high and low-density polyethylene [280], a critical literature survey with 43 references on the subject of gas permeability of plastic films and sheeting [281], and the effect of heat processing of packaging films at 212 to 250 F on water and carbon-dioxide permeability were also published [282].

Instrumentation. Improved measuring and instrumentation techniques for temperature and pressure as used in extruder development have been published [283, 284]. A case history described savings resulting from reduction in variation of impregnant amount through the use of beta-ray gaging [285].

Applications. The ingenuity of applying plastics in new and acceptable end-use areas has been historically a major factor in the growth of the industry. However, a major stumbling block to realizing the potential of many large markets is the lack of adequate design and

engineering data. In spite of this problem, several of these areas have been sampling plastics in an attempt to gain experience with these materials, and new applications still account for a large percentage of increased volume [286].

General. The utilization of plastics in the automotive industry [287] is increasing with new applications and more reliable experience with experimental uses [288, 289]. A small car has been designed specifically to take full advantage of the engineering potential of various plastics [290]. Plastics have been successfully used in the shoe industry [291], in refrigeration [292], in bearing applications [293] and as TV implosion guards [294]. Glass-reinforced epoxy for the fabrication of shotgun barrels [295], and cast epoxy for the production of low-cost molds [296], patterns [297], and models [298] represent a few of the successful applications of 1959–1960. Several sandwich constructions have been fabricated and evaluated [299, 300, 301]. Uniaxially glass-reinforced epoxy laminates have been successfully used in flat springs; in many applications these springs outperform their steel counterparts [302]. The use of plastics for several structural applications was considered together with design calculations for adequate performance [303]. Design rules for reinforced phenolics have been reviewed [304]. A compilation of the properties of major impact thermoplastics has been prepared in an attempt to give a guide to choosing the proper material to fit a specified application [305].

Building. The vast potential of the building-materials market has long been a prime target for large-volume plastics applications. Solutions to the best approach to utilization of plastics in building have been proposed [306], but lack of standards still stands as a deterrent to the widespread use of plastics in this area [307]. The establishing of the plastics family in building will involve research and educational efforts by the plastics industry [308].

One major step has been taken through the application and evaluation of plast cs for 53 specific uses in Monsanto's Inorganic Division Research building in St. Louis. Data from approximately three years' use indicates 30 applications were OK, minor problems with 15, and problems with eight. This and future data will be carefully studied by BOCA [309]. Uses of plastics in building construction [310], insulation [311], as aesthetic components [312, 313, 314, 315] in services [316], as roofing material [317], and for concrete forms and form linings have been reviewed [318].

A study illustrating the practicality of struc ural sandwich panels has been reported, complete with a detailed design for an elementary school in which such panels were used [319]. Use of polyester as a coating for cinder blocks with on-site application by spray techniques has been reported [320]. A review of development efforts in combining steel and plastics, to obtain results not possible with either mate ial alone, has been issued [321]. Use of reinforced polyesters in new installations, and as a structural maintenance mat rial, was reviewed in two articles [322, 323].

Pipe. Interest in plastic pipe fo potable-water service includes supply mains [324] and low-pressure polyethylene pipe (reports on exhaustive lab tests) [325] and polyethylene pipe for use in farming operations [326]. Use of plastic piping systems in the chemical industry requires a large additional amount of engineering data [327]. Progress in the use of plastics as binders, sealers, and cementing agents in clay pipe has been reported [328].

Foam. A listing of major foams, together with descriptions, advantages, disadvantages, preparation, and applications has been published [329]. In one major structural application, polyurethane foam was used as insulation and reinforcement between the inner and outer shells of a nuclear submarine with a resulting weight reduction of $8^1/_2$ tons from the previous weight [330]. Foams have been used as clothing insulation [331], as structural supports, potting material, packaging, and as high-frequency absorbers in the space laboratories of the U. S. [332].

Space Age. Intensive research conducted on space vehicles has included plastics application as a major consideration. Reinforced plastics have been used in critical applications, in rockets [333], rocket engines [334, 335], and missile components [336, 337]. Research results on radomes indicate that optimum construction may be achieved through a combination of plastics and ceramics [338]. The longevity and positive action of microminiature missile relays have been made possible through the use of TFE coil bobbins [339]. As theoretical and experimental work with plastics continues to be carried out, correlated, and declassified in the government's space program, valuable design information will become available to industry for promoting sound application of these materials [340] in nonmilitary applications. Engineers concerned with design of high-energy nuclear accelerators have found plastics to be superior materials for use in several specific reactor components [341]. Linear polyethylene has been successfully employed in neutron shielding, and combination with other materials results in both neutron and gamma-radiation shielding [342, 343]. The use of composite glass-and-plastic construction has been employed in high-speed aircraft glazing to obtain thermal resistance in range of 350 to 1000 F [344]. Several plastics have been extensively evaluated for use as balloon-barrier materials [345]. A general review has been made of applications of plastics in today's aircraft industry [346].

Electrical and Electronics. The insulation qualities of plastics have firmly established their position as electrical and electronic insulators. The relatively new encapsulation of electrical and electronic components takes advantage of both electrical and thermal-mechanical properties of certain plastics [347, 348, 349, 350]. Epoxy resins are widely used as encapsulating resins [351, 352, 353] as well as in other electrical applications [354]. The use of plastics for potted cables [355], cast-resin in switchgear and transformers [356], and as coatings for impressed circuits [357] has been reviewed. The use of ethylene and its copolymers as wire and cable insulation is considered [358, 359, 360, 361].

Adhesives. A number of applications have been developed utilizing structural adhesives formulated with polymeric materials. Vinyl-metal construction can be

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stamped, punched and drawn [362]; air-drop sandwich construction shelters were made possible through epoxy adhesives [363]; the entire wing area of some new jet aircraft can be used for fuel storage, due to new component-sealing systems based on nitrile-phenolic materials [364]. Concrete adhesives based on epoxy resins cut repair and construction costs [365]; and reinforced plastics can be effectively bonded to themselves or other materials [366]. Characteristics of various epoxy systems and nitrile-phenolic combinations were reviewed in relation to bond strength [367], and two articles described hot-melt adhesives [368] and hot-spray application techniques [369].

Coatings. The resistance of many polymeric materials to a variety of environmental conditions makes possible a wide variety of surface coatings, affording protection to less resistant substrates. Plastics have found wide use in corrosion prevention [370], fire retardation [371], weather resistance [372], and radiation [373] and thermal protection [374]. Polyesters [375] and polyurethanes [376] have been used in coating wood. Application reviews included solvent-solution coating [377], high-density polyethylene protective coatings [378], and urethane coatings [379].

Packaging. The packaging field continues to expand as a major market. The use of plastics in this field has been reviewed in several articles [380, 381, 382, 383]. Biaxially oriented polystyrene has been used as a produce overwrap [384] and polypropylene film is developing as a strong contender for many cellophane markets [385]. Polyethylene application as a coating for foils and cellophane has expanded [386], and plastics-coated paper, and combinations of plastics with other materials, are commanding attention as valuable packaging materials [387]. One of the major advances was the use of linear polyethylene for detergent bottles [388]. A relatively thin polyethylene shipping container within an octagonal wire-bound shell is claimed to be practical and 40 to 50 per cent cheaper than conventional steel drums [389].

Standards and Education

A new centralized "Plastics Technical Evaluation Center," under Defense Research, and Engineering, has been established at Picatinny Arsenal, Dover, New Jersey; "Plastec" will file translations of foreign reports and issue abstract cards and microfilms [390]. Information from monthly ASTM bulletins and working groups within ASTM have been summarized in two new books carrying specifications, methods of testing nomenclature, and definitions [391, 392]. The status of nine working groups on the plastics committee of The International Standardization Organization is reported [393]. The sources of plastic standards are summarized briefly [394].

Special new standards and tests for styrene-foam insulation [395], rigid PVC tubes [396], and for polyethylene film [397] were published. Governmental and military-specification indexes were published [398, 399, 400, 401].

An industry-supported research-and-educational plastics institute has been proposed; the industry has been canvased to determine if there is a need for such an institute [402]. One material supplier is giving a laboratory-and-lecture instruction course on the basics of alkyds [403].

Health and Safety

The status of the F.D.A. (Food Additives Amendment), and interpretations of what this legislation is likely to mean to the plastics indust y, have been reviewed [404, 405, 406]. The safety of colorants used in food packaging has been considered with respect to this amendment [407]. Leaching tests currently used for PVC compounds in determining their suitability for potable-water carriers have been reviewed [408].

A paper-bound SPI publication describing hazards and safe practices for materials, equipment, and processes has been issued [409]. A review of hazards in the manufacture and use of plastics has been made [410].

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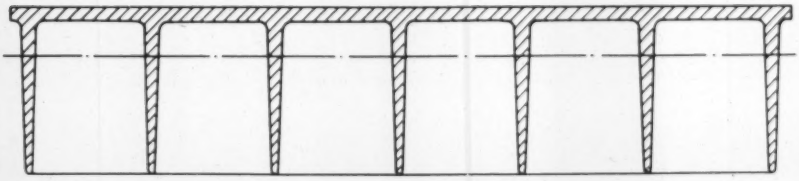

Fig. 1 Cast-iron surface plates usually have a configuration of ribs designed to resist deflection. These are cast with a pronounced taper to permit removal from the sand mold in casting. Uneven thermal expansion results since the ribs absorb temperature changes much more rapidly than the heavier sections and the cross section is not symmetrical about the neutral axis.

WELDED SURFACE

Traditionally, surface plates have been made of cast iron. Here is a step forward — welded

A SEARCH for a better material for the fabrication of surface plates, used in checking surface flatness, led to steel. Higher modulus of elasticity indicated decreased deflection and other advantages, but steel posed some problems in fabrication. For years, surface plates have been cast-iron tables or stone slabs with an accurate surface or surfaces produced by conventional machining methods, grinding, or hand scraping. The accurate surface is used to measure and check tools, fixtures, and workpieces.

Small workpieces are brought to the surface plate and the machined surfaces are checked for flatness by applying a thin uniform coat of "bluing" on the surface plate. Rubbing the workpiece on the surface plate transfers bluing to the workpiece at all points of contact, indicating the high spots. These are removed by hand scraping with a chisel-like tool. The process of bluing and scraping is repeated until the desired degree of flatness is obtained.

When scraping the bases and frames of large machines, the surface plate is brought to the workpiece. Thus the usefulness of a surface plate depends on its ability to remain accurate, even when it is transported about the shop and used in a variety of different positions.

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Types of Surface Plates

Stone surface plates retain their accuracy for long periods of time and are widely used as stationary tables, but they are frequently too heavy to be used as portable plates.

Stationary and portable cast-iron plates have been used since the beginning of modern machine-shop methods. They have been cast in materials ranging from cast iron to the best grades of semisteel.

The plate usually has a configuration of ribs designed to resist deflection, and these are cast with a pronounced taper or "draft" to permit the pattern to be drawn out of the sand in molding, Fig. 1. Dovetails, squares, steps, and clearance cuts are often included in the surface plate in order to conform to the workpiece. These added features usually create heavy metal sections because of casting limitations.

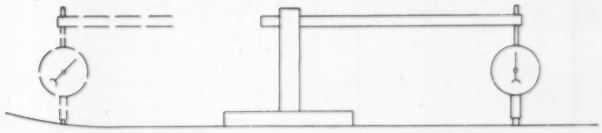
Deflection Problems

Surface plates are ground or hand-scraped with their surface "up." They are then turned upside down and checked against a master plate or against two other plates in a manner known as Sir Joseph Whitworth's "Three-Plate Matching System."[1]

Application of the completed plate to a large machine base or frame may require turning the plate upside down, or suspending it vertically from a crane.

[1] R. J. Rahn, "Whitworth Was Only Partly Right," *American Machinist*, April 20, 1959, p. 112.

Fig. 2 The dial indicator on a stand is a supplemental test for surface accuracy. The stand is moved from position to position and irregularities are indicated on the dial. High spots are laboriously removed by repeated scraping and checking.



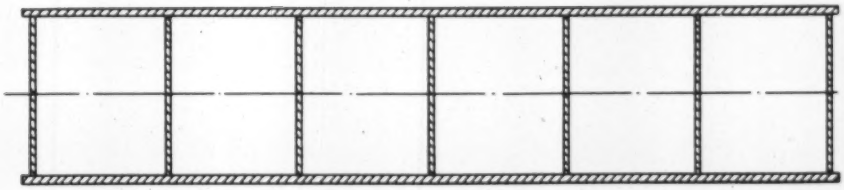


Fig. 3 A true box section cannot be cast by any known foundry methods, but welded-steel construction is a natural. Steel provides a desirable increase in modulus of elasticity, and weight can be reduced by the use of thinner sections.

PLATES

steel plate, light in weight, extremely accurate.

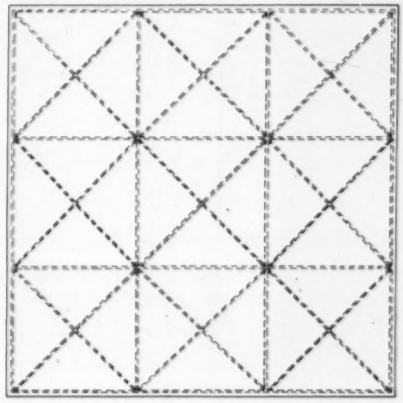


Fig. 4 A test layout was made of a 48 x 48-in. welded-steel surface plate with a web of ribbed reinforcements

The surface to be checked may be concave, convex, or a combination of other inaccuracies. The surface of the plate and the ribs are thus stressed in compression or tension as the situation varies.

The deflection is further aggravated by the fact that in casting the surface plate the tips of the ribs cool rapidly, resulting in a hard dense iron, while the heavier sections of the plate cool slowly resulting in a softer, weaker iron. It is almost impossible to cast a surface plate of a completely homogeneous material. According to the "Gray Iron Handbook,"[2] "The section size or cooling rate of gray iron influences the microstructure and, therefore, affects the elastic modulus. Increasing section thickness causes a decreasing modulus of elasticity."

The ribs of a surface plate absorb temperature changes more rapidly than the heavier sections of the plate, and uneven thermal expansion and inaccuracy result.

Cast-iron surface plates change almost continuously from the reversing of stresses, temperature changes, the lack of homogeneous material, and a cross section which is not symmetrical about the neutral axis.

A method of checking which supplements the surface plate is the dial indicator on a stand, Fig. 2. Any flat surface can be checked by moving the stand from position to position. False surfaces detected by the indicator must be rescraped in an almost endless cycle which wastes untold hours of skilled labor.

[2] C. F. Walton, "Gray Iron Castings Handbook," Gray Iron Founders Society, Inc., Cleveland, Ohio, 1957, p. 139.

Solution of Problems

Surface-plate deflections were investigated by using an equation for a beam of uniform loading, supported at the ends

$$\text{Deflection} = \frac{5}{384} \times \frac{WL^3}{EI}$$

where

W = total weight of surface plate
L = length of surface plate
E = modulus of elasticity
I = moment of inertia of cross section

A study of the equation reveals that the deflection will decrease when: W is reduced, E is increased, or I is increased.

A "box" section would be an ideal way to increase I, but a true box section with internal ribs cannot be cast by any known foundry methods, Fig. 3. Welded-steel construction is a natural. Steel increases E from an average of about 16,000,000 to 30,000,000. Since steel can be fabricated of thinner sections, W can be maintained or reduced, even in a box section.

Since surface plates are often used in an inverted position, the deflection of an inverted plate would be double that shown in the equation, all things being equal.

A 48 × 48-in. surface plate was required for the scraping of the ways on the base of a jig borer. A layout was

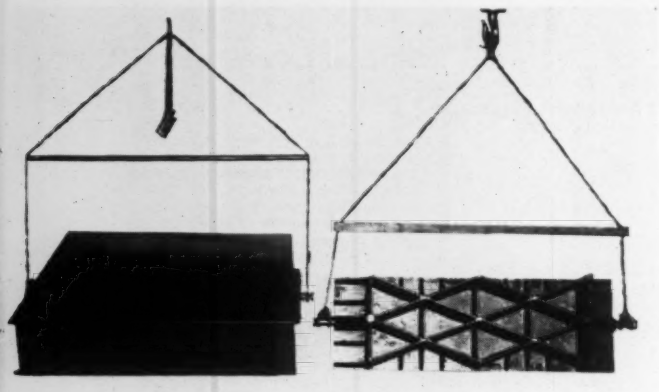


Fig. 5 The welded steel plate showed an improvement of 358 per cent over the cast-iron design. Two usable surfaces were provided — one for rough checking and one for finish checking.

made of a welded-steel surface plate with a webbing of ribs, Fig. 4, and

$$\text{Deflection} = \frac{5}{384} \times \frac{1460 \times 48^3}{30{,}000{,}000 \times 1243.5}$$

or 0.000056 in.

Since no cast-iron plate of this size was available, a hypothetical section was assumed for a comparison, using the same weight as the steel plate:

$$\text{Deflection} = \frac{5}{384} \times \frac{1460 \times 48^3}{16{,}000{,}000 \times 660}$$

Deflection was found to be 0.00020 in.

The welded-steel plate showed an improvement of 358 per cent over the cast-iron design. A reduction in weight of the welded-steel plate would show an even greater improvement.

A study of the layouts revealed the following additional advantages over the cast-iron surface plate:

1 A symmetrical cross section about the neutral axis prevented errors caused by alternating compressive and tensile stresses, Fig. 3.

2 Uniform thickness reduced thermal errors to a minimum.

3 There were no exposed edges of ribs to respond quickly to thermal changes.

4 Soft, hard, strong, and weak areas were replaced by a comparatively homogeneous material.

5 Two surfaces could be used—one for rough scraping and the other for final scraping and checking. These did not need to be absolutely parallel. An uneven thermal expansion where one side was exposed to heat, the other to cold, would cause the entire surface plate to change, one surface becoming concave and the other convex. By applying the "finish" side to the workpiece, this could be detected immediately without supplemental means.

6 Since no pattern would be necessary, savings over the customarily tailor-made larger sizes would be considerable.

Since chemical composition and heat-treatment do not affect the modulus of elasticity, the properties desired in the steel were stability and wear life. The steel should retain its original hardness after stress-relieving. This indicated a low-carbon alloy steel. United States Steel Constructional Alloy T-I, Firebox Quality, was chosen for the fabrication of the surface plate. This is a well-controlled steel from a manufacturing viewpoint, and is capable after heat-treating of the same physical characteristics in both the longitudinal and transverse directions.

The welder was instructed to cut all ribs and end plates of the same height, and if necessary to machine the edges in order to insure a uniform amount of weld at all joints. The center ribs were assembled and welded first. Successive ribs were added around the center. The end plates were plug welded to the adjoining ribs. Continuous welds were used all around except at these plugs. This was done to give maximum support to the top and bottom plates, and to keep as uniform a pattern as possible.

All compartments were vented by drilling $^1/_4$-in. holes in ribs and sides to prevent air pressure from building up.

It was decided to stress-relieve at 1000 F and to remove from the furnace at 800 F for air cooling. The heat-treater was instructed to use a flat hearth or to bed the surface plate in sand to prevent warpage. This method of stress-relieving proved completely satisfactory.

After machining, it was hand scraped to an accuracy of 0.000050 in.

The cast-iron plates are rescraped several times a week in an attempt to keep them true. The steel plate is rescraped every 2 or 3 months, depending on the use it receives. It takes 12 hr to rescrape one side of this 48-in-sq plate.

What a saving in maintenance of the surface plate alone!

Tests

The welded-steel surface plate was supported over a master stone plate, using a three-point suspension. The bottom side of the steel plate was checked with a tenth dial indicator on a stand which was riding on the stone plate. The maximum error detected was 0.0001 in. The steel plate remained in this position for 4 hr, during which time the temperature in the shop rose 10 F. All checks during this time showed the same 0.0001-in-error.

Since no 48-in sq cast-iron surface plate was available for testing, it was decided to use a 16 × 48-in. cast plate for comparison. This plate was scraped to the same accuracy of 0.000050 in. It was supported in an inverted position above the stone master plate, and checked with the same dial indicator. The plate was checked immediately and showed an error of 0.0003-in. deflection along one edge and 0.0007-in. on the other. One hour later this error had increased to 0.0005 in. and 0.0008 in. At the end of 4 hr the error was 0.0001 in. and 0.0004 in. The temperature in the shop had increased 8 F, causing the ribs of the cast plate to expand rapidly, straightening the surface plate.

To say the least, such uneven and excessive deflection, coupled with the thermal changes, makes such a surface plate difficult to use.

RESEARCH IN BULK MATERIALS HANDLING

By M. J. Erisman, Mem. ASME, Link Belt Company, Chicago, Ill.

Industry looks for ways that are faster, easier, and cheaper for moving bulk materials. Engineers find there's many a slip 'twixt the specification and the successful conveyer.

ONE of the newest forms of applied research is the field of Bulk Materials Handling, a field in which empiric practices are now beginning to yield to engineering inquiry. By some definitions, bulk-materials-handling research is still in its early stages, but results already achieved are opening up vistas not only for more accurate and efficient application of existing equipment, but also are telling us where more basic research could produce significant results.

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The Educated Guess

We established our laboratory because too often the selection of conveying equipment has been more a matter of personal experience and precedent than engineering based on established axioms. Too often, precedents are valueless because they are dependent upon the acuity, judgment, and breadth of experience of the individual whose experience is being used as a guide.

The span of our work has included all kinds of mechanical-conveying media for a wide range of bulk materials plus, of course, a study of our equipment and of the characteristics of materials. The latter include size, flowability, abrasiveness, and a wide assortment of

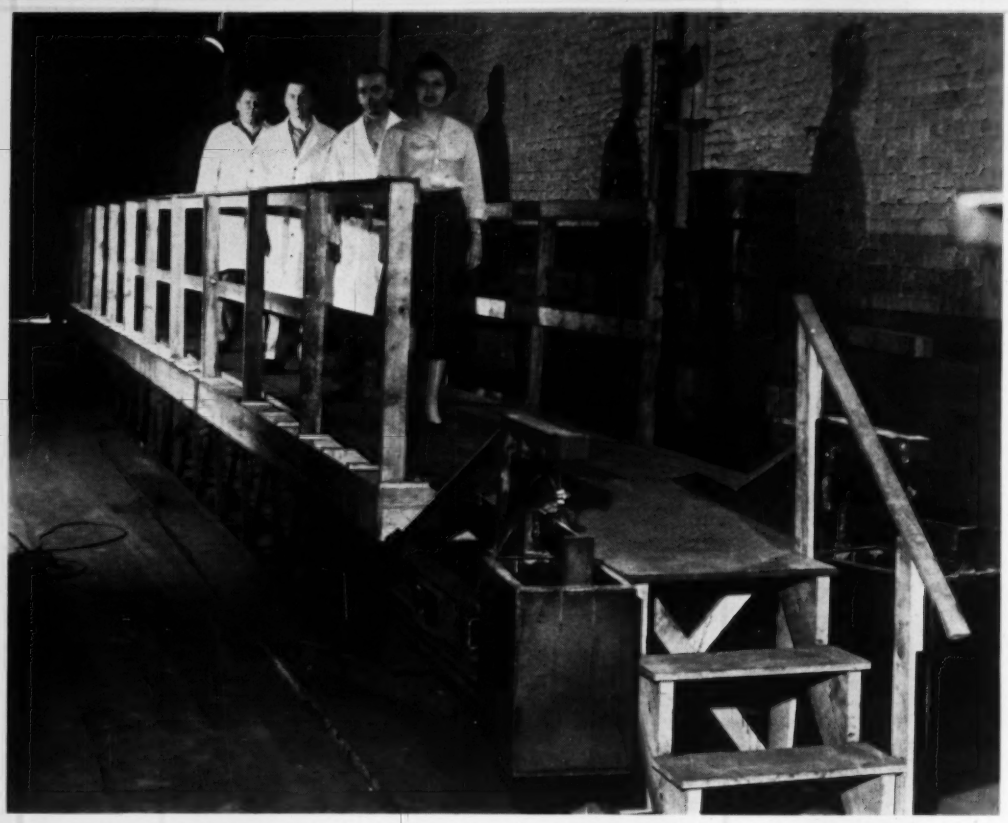


Fig. 1 To the materials-handling engineer, people can be a bulk material (shown here on a belt conveyer). As a material, people would be classified as irregular in size, abrasive, having an angle of repose in excess of 45 degrees.

special characteristics, many of which had been ignored.

Materials may or must be carried, pushed along, dragged along, moved along by gravity, dug up forcibly, or fed gently. Not all materials may be handled in the same way. Many can be handled in one of several ways with little measurable difference. A further complication often results in the manner a material behaves when it finds itself in company with equipment.

Still other variables are posed by the changes which occur in the most common materials due to changes in methods of mining, manufacturing, and processing. All can alter the manner in which the materials are handled today.

For example, our designs for power-plant coal-handling equipment have changed because coal, once mined by hand, is now mined mechanically. When coal was hand-mined, it was crushed to minus 2 in. in size, and could be handled satisfactorily with 45-deg slopes on hopper, chutes, and belt conveyers. Today, as we are obliged to mine low-quality reserves with mechanical miners which cut away both coal and shale, coal must be beneficiated and as part of the process reduced to minus $^3/_8$ in. It is now necessary to use 55 to 60-deg slopes because the angle of repose of coal has changed from 40 to 50 deg and more.

Since some materials receive a form of processing while they are being conveyed, we must work closely with processors to fulfill their requirements while at the same time providing for maintenance of the equipment. Often another problem is restricted space in which to perform the conveying function, due to the existing size or shape of a structure. Where a belt conveyer may be indicated, lack of space may permit only a bucket elevator, but owing to the nature of the material a bucket elevator may be inherently unsuited. Then what? Where should the compromise be made? Such compromises often are unavoidable and expensive.

Some industries, like chemicals and food, can impose stringent conditions which affect the design of materials-handling equipment. The government may add Bureau of Animal Industries laws and inspections that tax the ingenuity of the designer to avoid product degradation and contamination.

The need for more precise knowledge about conveyers suggests that we obtain a better knowledge of the materials, and that we establish a relationship between materials characteristics and the kinds of conveyers best suited to handle individual materials.

Conveyability of Materials

As one of our promising lines of inquiry, we have developed a table which enables us to list characteristics of a material in terms of the materials' conveyability (Table

Table 1 Conveyability of Materials

	Material Characteristics	Class
Size	Very fine—minus 100-mesh	A
	Fine 100-mesh to $^1/_8$ in.	B
	Granular $^1/_8$ to $^1/_2$	C
	Lumpy—containing lumps $^1/_2$ in. and over	D
	Irregular—being fibrous, stringy, or the like	H
Flowability	Very free flowing—angle of repose up to 30 deg	1
	Free flowing—angle of repose 30 deg to 45 deg	2
	Sluggish—angle of repose 45 deg and up	3
Abrasiveness	Nonabrasive	6
	Mildly abrasive	7
	Very abrasive	8
Special Characteristics	Contaminable, affecting use or salability	K
	Hygroscopic	L
	Highly corrosive	N
	Mildly corrosive	P
	Gives off dust or fumes harmful to life	R
	Contains explosive dust	S
	Degradable, affecting use or salability	T
	Very light and fluffy	W
	Interlocks or mats to resist digging	X
	Aerates and becomes fluid	Y
	Packs under pressure	Z

1). This table consists of "special size," "flowability," "abrasiveness," and then a wide assortment of "other factors" such as explosiveness, corrosiveness, hygroscopicity.

Our next step is the difficult one of relating the various conveyability characteristics to specific kinds of conveyers. The optimum development will come when the various conveyability characteristics, together with capacity and other pertinent factors, could be fed into a data-processing machine which would then select the specific kind of conveyer.

For example, use this table to classify two materials that have been handled on conveyers. The first is sugar which we symbolize as B26KT. The first figure shows the size of the material, the second its degree of flowability, and the third its abrasiveness, and so on. These all indicate considerations necessary in the selection of a specific kind of conveyer. Experience and tests have shown that a screw conveyer, if selected oversize, will fulfill the requirements. What we are now striving to develop are series of permutations of varying characteristics of different types of materials.

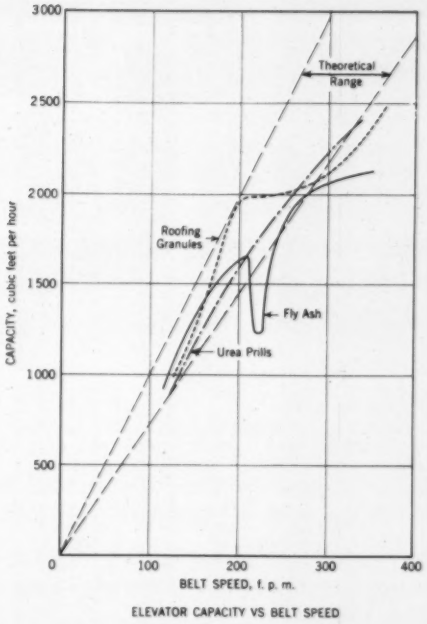
If a specific type of conveyer is required due to certain area limitations and has never been used in this particular field before, a test might indicate if a standard could be used, or how it should be modified. Our sugar example gave five factors, but next is a problem with nine factors and we are not certain that even nine are adequate.

The problem consists of handling a mass flow of people between two points on a horizontal plane. Belt conveyers are being used for this purpose (Fig. 1). We might set up a class such as H38KRSTXZ. "H" indicates irregular size, fibrous, stringy, and the like; "3" indicates the product is sluggish with an angle of repose of 45 degrees and up; "8" shows that it has a tendency to be very abrasive—definitely not a problem to be solved with a screw conveyer. Of course, you must treat folks kindly and carefully to avoid injury. Conveying equipment, if misapplied to materials, wears out rapidly or breaks down; if misapplied to people, lawsuits and claims for damage result.

No Data on Abrasion

Abrasion presents another serious problem which requires far more specific knowledge than we now have. There are tables for modulus of elasticity, chemical structures, weights, coefficients of friction, coefficients of thermal and electric conductivity of many metals, and there are measuring scales for intensity of light, sound, and hardness, but there is nothing available for the measuring or defining the important factor of abrasion. Yet, the abrasion factor has probably more to do with the life expectancy of almost any type of bulk-material-handling equipment than any one single factor.

In referring again to our material classification chart (Table 1), you will notice that we set up three degrees of



ELEVATOR CAPACITY VS BELT SPEED

Fig. 2 Bottom: Operating inside the vertical duct is a bucket conveyer. The problem: To increase the capacity for a given-size bucket line. This one uses centrifugal discharge.

Fig. 3 Middle. The head wheel was fitted with a plastic hood to facilitate study of centrifugal discharge. Initial discharge took place 90 to 120 degrees sooner than had been expected.

Fig. 4 Top. Discharge capacity versus belt speed. At a critical speed range, discharge failed to rise with speed, actually falling off when fly ash was the material.

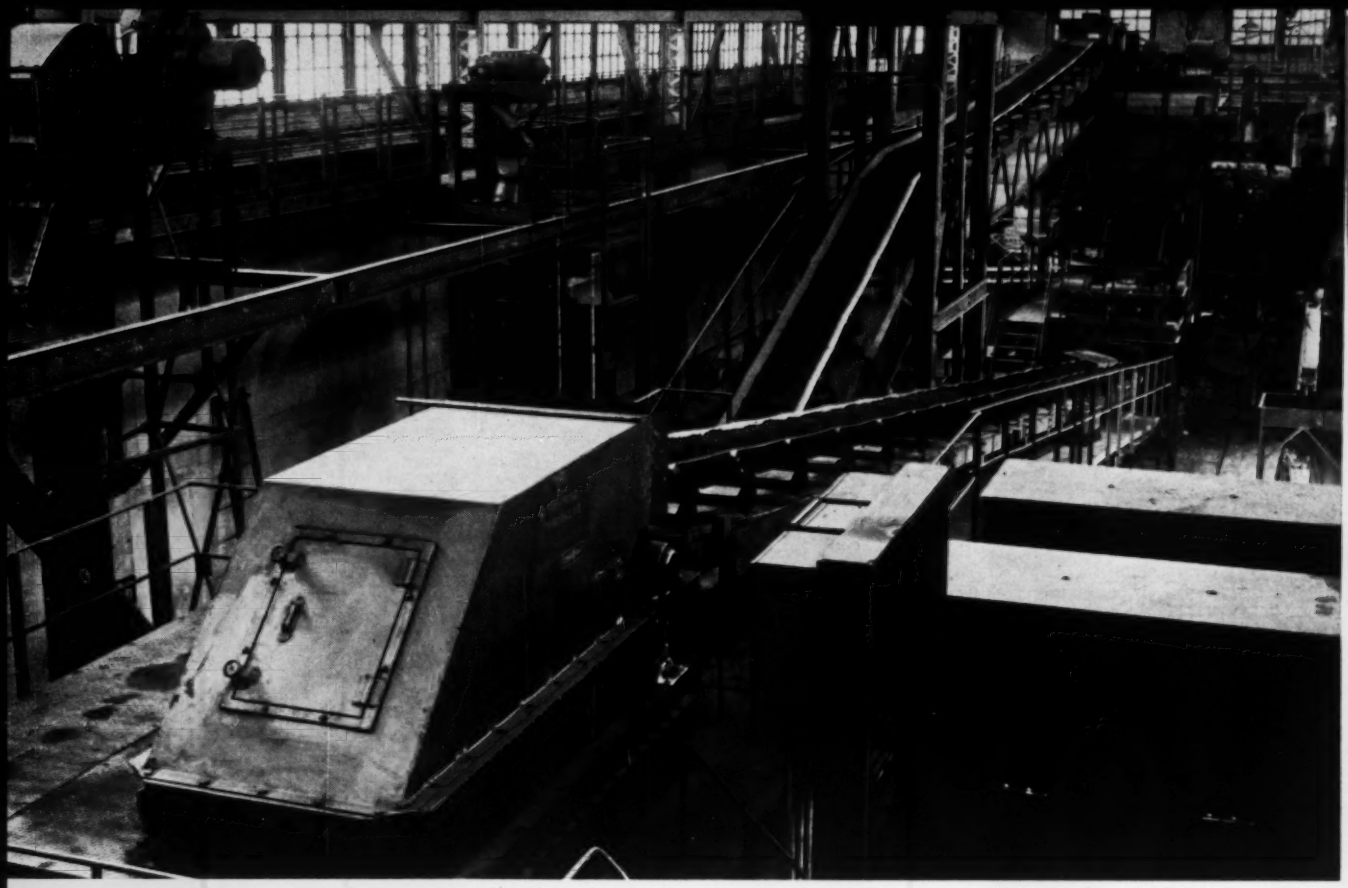


Fig. 5 With conveyer belts, the problem is to increase the capacity for a specific width. Since conveyer systems include transfer or discharge points, maximum speeds are limited by trajectories permissible at these transfer points.

abrasiveness—nonabrasive, mildly abrasive, and very abrasive—but each degree lacks a defining common denominator. Each degree may be a matter of personal opinion. We are making abrasion studies and while we have been sufficiently encouraged to continue, we feel the study of abrasion is of vital importance to all industry and warrants a much more intensive research program than we can devote to it.

The abrasion factor applies in a very special way to screw conveyers—supposedly an invention of Archimedes. En-masse conveyers such as Bulk-Flo, which move materials in part by cohesion of particles, have their very life expectancy hanging on the abrasion factors. Laboratory tests have indicated where misapplication starts.

Work has also been performed with other conveyer types not so common in application, some of which have great potential for handling materials, if we could solve the problems inherent in the relationship between the material and conveyer.

Two kinds of equipment for handling material in bulk that are going through a change due to research are bucket elevators and belt conveyers. With methods and materials used in their construction fixed, for all practical purposes, ways and means had to be found to reduce the cost per ton of material handled by increasing the performance.

Bucket Elevators

In bucket elevators, the problem was to increase the capacity for a given-size bucket line. Most equipment manufacturers furnish bucket elevators in three basic types: Centrifugal discharge, perfect discharge, and continuous discharge. The centrifugal-discharge type is the most widely used. These have been applied as low-speed and medium-speed elevators for most materials, and high-speed types which are used widely in the grain industry (grain is relatively easy to catalog in our table). If it would be possible to operate the elevator line at higher speeds, it should seem possible to increase the carrying rate proportionably. If this were true, then the easiest way to provide a greater capacity for the dollar of equipment will be just to run it faster.

We built a so-called high-speed unit according to accepted principles as outlined in academic treatises on the subject, fitting it with a plastic hood to aid in our observations (Figs. 2, 3). We then turned up the speed to almost double what was considered sound practice.

Two major conditions were observed that differed from those predicted. First, initial discharge from the bucket takes place anywhere from 90 to 120 deg sooner than most theories say that it will occur; second, the speed-versus-capacity curve is not a straight line.

In considering the first observation, we found that initial discharge from the bucket takes place on the up leg of the elevator, just as soon as the bucket line starts to articulate around the head wheel. This is independent of bucket design, and the amount of this initial discharge is in relation to the speed.

The material in the bucket as it is being elevated has, of course, the same forces acting upon it as on the bucket itself. This includes what we might call a vertical velocity. As the bucket starts around the head wheel, its vertical velocity starts to decelerate rapidly, becoming

zero at the vertical point of the head wheel. As the bucket is open top, and there is a lack of communication between the bucket and the material being carried, the material attempts to maintain its same vertical velocity, and no doubt would completely unload if it were in a vacuum. Windage and hood design deflect most of the material back into the bucket; it is carried around to the point where centrifugal discharge takes place. However, when operating with full buckets at speeds of 500 feet per minute or faster the discharge will never be 100 per cent clean.

Centrifugal Discharge

The second observation is a phenomenon regarding the centrifugal-discharge action itself. Depending on the material-handling characteristics of the material, size of head wheel, and speed, the speed-capacity relationship will develop along a particular curve until it will suddenly flatten out, or in some cases actually dip into a pocket, as it were (Fig. 4). If the speed is further increased, the capacity will again increase, but at a different rate than in the first part of the curve.

This was discovered when our company furnished a standard elevator at a standard speed, to handle a different type of material, on which we had no operating data. The user had a justifiable complaint because the unit was delivering only about half of the expected tonnage. We were able to duplicate the conditions in the laboratory and found that by either slowing down or speeding up the bucket line as little as 40 fpm, contract capacity could be fulfilled.

This critical condition has been analyzed as occurring when the weight of material actually in the bucket is equal to the centrifugal force exerted by the material in the bucket, combined with the coefficient of friction of the particular material with the discharge edge of the bucket.

Understanding these factors for the various materials has led to the design of the so-called "hi-speed" elevators now so widely used. Where these same factors can be known for other types of materials, it has led to the applications of these advantages in handling many other materials. One of the deterrents here is the abrasion factor.

Belt Conveyers

In belt conveyers (Figs. 5, 6) our problem is to increase the capacity for a conveyer belt of a specific width. Since conveyer systems include transfer or discharge points, maximum speeds are limited by trajectories permissible at these transfer points. The other possibility then is to increase the cross-sectional load.

Again, as with bucket elevators, there have been certain designs that have been used with grain and grain only. It is common practice to use belt-conveyer idlers for grain with the side rolls at 45 deg instead of 20 deg, increasing the cross-sectional area by nearly 40 per cent. It can be shown that 45 deg is the mathematical maximum. With grain having relatively light weight, lighter conveyer belts have been used which conformed to the deeper-troughed idlers without damage to the belt. When it was suggested that we do this for heavier materials, we were informed that, due to the heavier belt required to carry the heavier load, the contortions of the belt would be too great and the belt would break at the crotch between the idler rolls. A lighter belt would be too flimsy and not support the load.

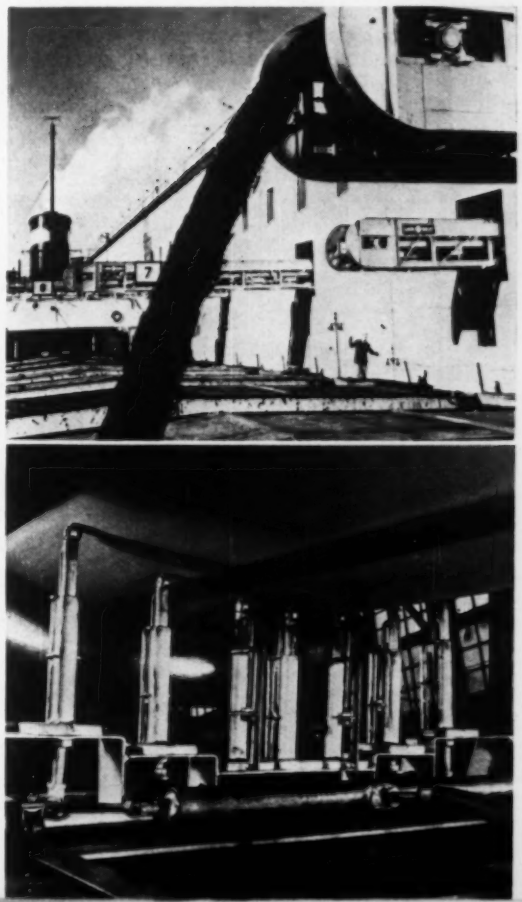
Dr. T. L. Williams of du Pont Company and the writer were given the opportunity to consider this problem. Du Pont would furnish lightweight, high-strength fibers that could be made up into a very flexible "flimsy" conveyer belt, but one that would meet the strength requirements in the known area of calculations. The laboratory would take practices that were reserved only for lighter materials and make up a conveyer to handle the heaviest bulk material we could find in quantity. Conveyability and belt life would be the measuring stick of performance (Fig. 7).

The results have been widely advertised in the industry. Belt manufacturers now claim their belts will handle anything on deep-troughing idlers, and equipment manufacturers are publishing tables of capacity which indicate the savings possible when moving large volumes of material in the bulk. To quote from our laboratory report: "In general, the performance and load-handling ability of the belt under the greater load on deep-trough idlers were superior to those when handling the standard load on 20-deg idlers. The belt trained equally well and showed no tendency to spill from the edges. The bottom contours of the belts were similar in shape, and the edges tended to stand higher than the so-called standard, which is the reverse of what had been predicted."

We have touched briefly on only two areas of a wide-ranging problem where a little applied research has brought interesting results. Work is being carried on in other areas on other forms of bulk-material behavior in bins and silos. It is a problem of continuing interest because of all the many new materials that are coming into use.

Fig. 6 Top. Conveyer and bulk material part company

Fig. 7 Bottom. Looking at the underside of a test belt. The belt-supporting idlers are in the rear. The small rollers in the foreground are for measuring belt sag.



Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Associate Editor

BRIEFING THE RECORD

Roller Roads

A HIGH-SPEED electrically driven system of "Roller Roads," conceived by Westinghouse Electric Corporation, would transport groups of automobiles and their occupants at speeds up to 150 mph or commuters at speeds up to 75 mph. In this conception advanced by Westinghouse engineers Charles Kerr, Jr., Mem. ASME, and Clarence Lynn, Mem. ASME, the roadway would consist of a series of rubber rollers spaced approximately 20 ft apart to resemble large inverted roller skates. Powered by individual motors, these rollers would both support and propel flat-bottomed carriers in which automobiles and passengers would travel.

John A. Hutcheson, Mem. ASME, Westinghouse vice-president of engineering, said the Roller Road has potential for solving problems of highway traffic congestion and metropolitan rapid transit service in the near future and would provide more reliability and safety than any proposal Westinghouse has seen.

In an address before the 40th annual meeting of the highway research board of the National Academy of Sciences, Lawrence R. Hafstad, General Motors' vice-president and director of research, mentioned the Roller Road as one of several promising approaches for solving interurban-transportation problems.

Mr. Kerr and Mr. Lynn said the need for a new concept was suggested by their belief that conventional methods of intercity "turnpike" travel will be inadequate when our present 61,000,000 automobiles registration exceeds the 100,000,000 mark expected in the 1970's. In examining ways in which new highway systems might be constructed, airborne conveyances, monorails, electrified trains, self-propelled trains, and other concepts were considered, but only one seems to offer the best chance of providing the extreme reliability needed without sacrifice in other essential requirements.

In essentials, the new concept is as follows:

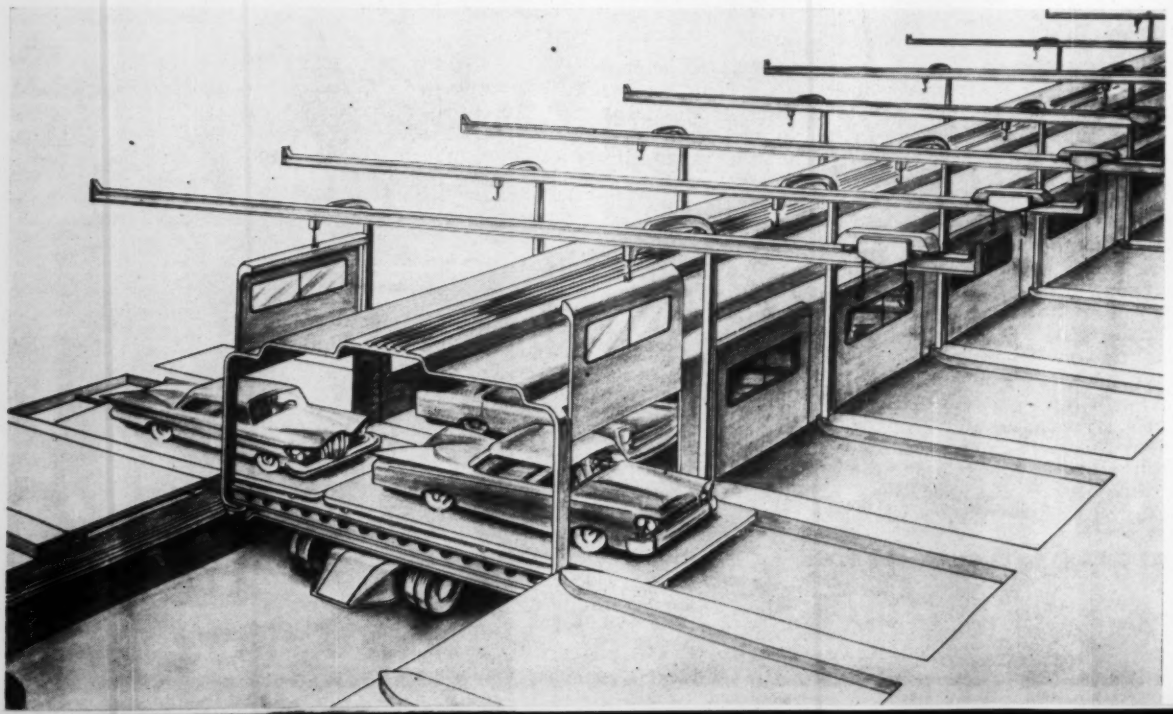
The conveyances which carry automobiles will be devoid of all apparatus whose failure might cause a highway shutdown or delay.

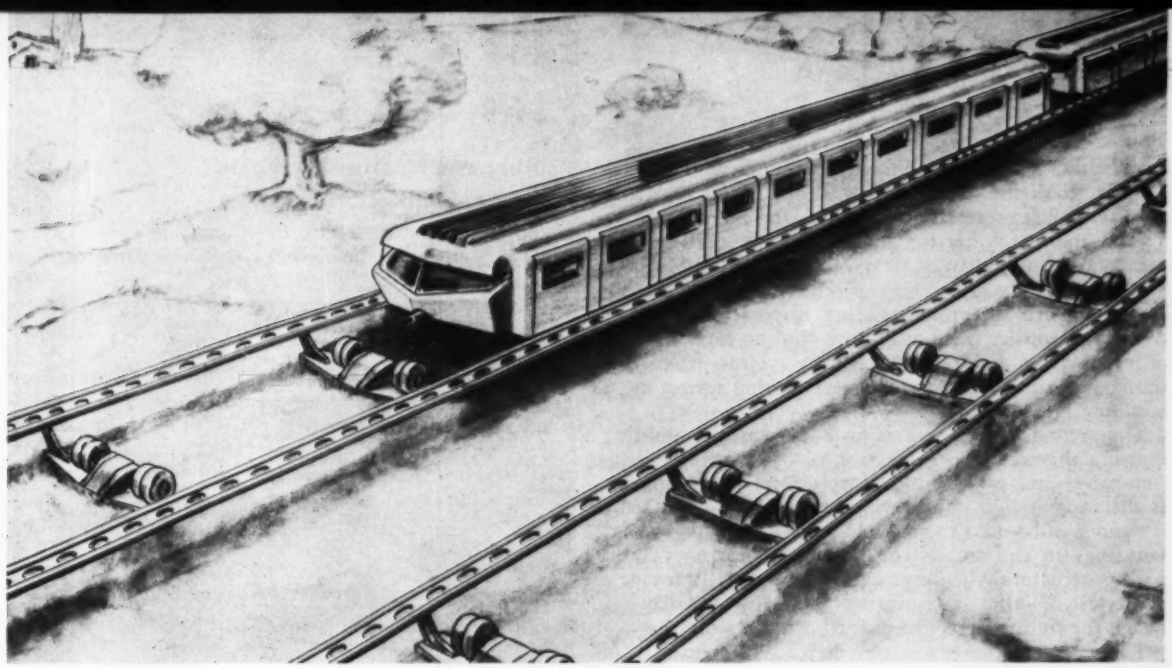
Each lane of the highway will be a continuous, computer-controlled system of individually powered rollers, receiving electric energy from neighboring interconnected electric-utility systems. This roller system will not only be the highway surface, but will accelerate the conveyances, keep them moving once accelerated, and provide braking power at proper locations.

The conveyances will be stopped at fixed stations where automobiles will be loaded and unloaded automatically to achieve uniform loading in minimum time.

Each carrier would be approximately 110 ft long with

Once the driver parks his car on a dolly, all other operations are computer controlled in the Rolle Road system. Doors open automatically, dollies shift, and the 110-ft-long 10-auto carrier is ready to move again 1 min after arriving at the loading dock.





Roller Roads would electrically propel flat-bottomed carriers at 150 mph to carry twice the volume of a modern turnpike. Computer-controlled three-phase induction motors operate 5 sec while a conveyance passes over them and then idle until the next one arrives.

provision for 10 automobiles plus a lounge with rest-room facilities.

The carriers would be operated in strings of 3 to 10 units under normal conditions. The only factor limiting the number of carriers would be the length of the loading platforms.

Guide wheels operating against the rails at either side of the Roller Road would steer the carriers along the rollers. As the only rotating devices on the carriers, these wheels could also be used to power generators to supply light and heat inside the carriers.

The drive package for each roller would consist of a three-phase induction motor, a torque converter, a brake, and a reduction gear. The time required for an 1100-ft string of 10 carriers to pass over a given roller at 150 mph is about 5 sec. Consequently, these motors would work for 5 sec and then would idle until the next conveyance came along. The motors thus could be heavily "overloaded" for short peak intervals, greatly reducing their size. A mechanical brake would be included on each roller to provide for emergency stops anywhere along the highway.

A loading and unloading time of 1 min was set as a goal in order to maintain an average speed of 120 mph over the highways. Drivers intending to board a carrier would place their cars on dollies at platforms adjacent to the highway. This would be the last action required of the driver until he and his car were automatically unloaded at his destination.

Computer Aids Loading. Computer-controlled lights would indicate to a driver which spaces were empty on the approaching carrier. When the carriers stop, automatic devices attached to the station platform would raise the proper doors on each side of the carriers. With the doors raised, a mechanical device would push the dolly and the car onto the carrier. The corresponding dolly on the carrier, whether or not it carries an automobile, would be pushed off the carrier onto the other side of the platform.

Consideration was given to the possibility of people driving automobiles on and off the carriers, but was discarded because of the uncertainties of human behavior. The computer control for the system would dispatch strings of carriers at proper intervals; provide protection against rear-end collisions should any string of carriers be stopped; control the automatic loading and unloading at stations.

Mr. Kerr pointed out that: "The major problem in an automatic system designed to handle the tremendous traffic of modern turnpikes is that of reliability in the propulsion system. While the Roller Road concept naturally introduces many problems, it encompasses the only propulsion plan which we have seen that seems to offer the reliability needed to make a high-speed system of this kind workable."

Advantages. A system of this kind would include the following advantages: (*a*) It can handle conventional toll-road traffic at twice the speed; (*b*) capacity could be increased with little expense by running more than 10 carriers together as an operating unit; (*c*) high-class freight could be carried in containers at speeds comparable to the airlines; (*d*) an all-weather route, it is invulnerable to delays from fog, ice, sleet, or snow; (*e*) passengers who desire to travel without automobiles can be carried at high speeds; (*f*) the same principles could produce an excellent rapid-transit system for large urban communities.

Air-Source Heat Pumps

THE first large-capacity heat pumps to use outside air as the source of heat in winter have been developed and installed by Carrier Air Conditioning Company. One is in a factory-warehouse, the other in an existing office building.

The factory-warehouse installation will be at the new $1-million Masland Duraleather Company plant in Mocksville, N. C. Summer temperature will be 80 F, winter 72 F, with 50 per cent relative humidity maintained year-round throughout the 140,000-sq-ft plant.

The heat pump is expected to cost only $5500 a year to operate as compared to $10,000 annually for conventional heating and cooling, while the first cost would have been about the same. The owning and operating cost study

by William F. Lotz, Inc., engineering firm of Philadelphia, took into account low electric rates resulting from two-shift processing at the Masland plant.

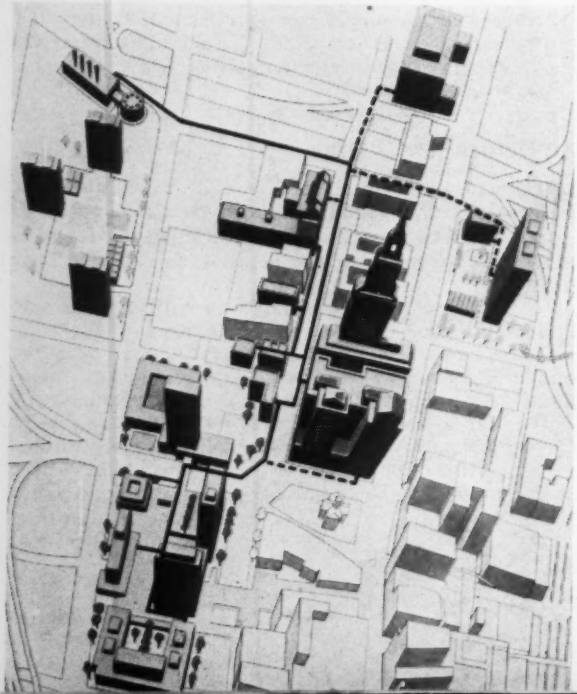
Cold and hot water for maintaining the desired temperature and humidity levels will be supplied at Masland by an electrically driven Carrier centrifugal refrigerating machine with 200-tons cooling capacity. Another centrifugal chiller rated at 80-tons cooling capacity will provide water for process chilling. Heat from this source will supplement the air-conditioning system as an economy measure.

The second installation is in a 40-year-old building housing the service organization of the Detroit Edison Company, and is scheduled for turn-on next summer. It will use two heat pumps with a total of 450-tons capacity and will be used to evaluate possibilities for various buildings in the area. The northern location of this narrow structure with large exposed areas will provide a good test. Valley Engineering Company of Glenside, Pa., is the consulting engineer for both installations.

Last year, Carrier officials predicted widespread use of heat pumps in large buildings after receiving a contract for an indoor air-source system to heat and cool the new eight-story headquarters and research center of the Allen-Bradley Company in Milwaukee, Wis. That system absorbs surplus heat generated by people, lights, and machines in the interior areas and transfers it to perimeter offices where heat loss is greatest. Its 1400 tons of cooling capacity make it the largest of its kind.

To perfect the new system, Carrier developed a nonfreezing method of extracting heat from outside air with temperatures as low as 0 F. In this method, air is pulled through a large coil containing antifreeze, similar to that used in automobiles. This liquid, at lower temperature than the outside air, absorbs heat from the air. The heat is "pumped" in the refrigerating machine to water which is circulated to air-conditioning apparatus throughout the building.

"With water for use as a heat source not available in sufficient quantity and quality in most geographical areas, almost all large heat-pump systems will use either outside air or take heat from inside air such as at Allen-Bradley," Russell H. Gray, president of Carrier Air Conditioning Company, predicted.



Cooling and Heating by Pipeline

SALE of cooling and heating through utility pipelines is about to begin in Hartford, Conn., and will soon become an important new source of income for utilities in other major cities.

The new service will increase summer gas usage substantially to balance the currently heavy use of gas in winter for heating.

In addition to eliminating the duplicate equipment needed for single-building installations, the central-plant approach cuts first cost per ton for cooling equipment, can lower fuel costs through quantity discount, frees building space for more useful purposes, relieves the building operator of some of his capital investment and his mechanical responsibilities, and permits better smoke control.

The chief disadvantages affecting cost are the length of pipelines and the problems of putting them underground, thus establishing the need for a concentration of air-conditioning requirements in one area, which frequently occurs in urban redevelopments.

The Hartford Gas Company is investing about $3 million for a central plant and two miles of steam and chilled-water pipelines to provide metered steam and chilled water in downtown Hartford.

The new plant will be completed next year and gross revenues from buildings purchasing heating and cooling are expected to reach $1 million to $1.5 million annually within four years. Carrier Air Conditioning Company, Syracuse, N. Y., will produce the huge water-chilling machines for the system.

Analyzing urban-redevelopment possibilities, Russell H. Gray, president of Carrier Air Conditioning Company, cited a list of 50 projects across the country which, with nearby buildings, would require an estimated $^2/_3$ to $^4/_5$ of a million tons of cooling. If utilities were to provide cooling and heating service, the gross revenues could total $80 to $100 million annually, he said.

The central plant will have an initial capacity of 6500 tons of refrigeration and 150,000 lb of steam. Chilled-water-supply and return lines 2 ft in diam and steam-supply and return pipelines 1 ft in diam will extend some 3600 ft from the plant. Carrier is supplying one 3000-ton and two 1500-ton steam-operated centrifugal cooling units plus one 500-ton steam-energized absorption-cooling machine.

The system initially will serve Constitution Plaza which is a cluster of three office buildings, a hotel, a broadcasting facility, and a shopping center being constructed as the first step in Hartford's huge downtown redevelopment plan. It will also handle air-conditioning requirements for the main office building and a number of other buildings operated by the Travelers Insurance Company of Hartford, sponsor of Constitution Plaza.

The Hartford Gas Company expects eventually to increase the size of its central plant to at least 10,000 tons to serve other projected redevelopment areas.

The engineering firm of Seelye, Stevenson, Value and Knecht made the economic studies and designed the plant. General contractor is the F. H. McGraw Company.

Cooling and heating will be supplied to the buildings connected by the pipeline to the plant at **upper left** in this aerial perspective of downtown Hartford, Conn. Dotted lines indicate probable customers, lightly shaded buildings potential customers.

Final check is made of a computer-designed computer. Instruction sheets which even specified length and path of the wiring were automatically produced, as well as the logic network.

Computer-Designed Computer

A COMPUTER has been built from complete wiring information and parts lists furnished by another computer by Bell Telephone Laboratories engineers. The entire logic network of the digital computer, for an Army target-tracking application, consisting of 47 subassemblies, was built from wiring diagrams, assembly information, and parts lists produced by a specially programmed, general-purpose digital computer.

Less than 25 min per subassembly was required to produce manufacturing information which would have consumed four man-weeks of manual effort with conventional drafting methods. Experiments are under way to convert this information into a control program for an automatic wiring machine, which would do the actual assembly work.

The first step in designing the computer was the synthesis of the logic network to perform the necessary functions. This network was then converted into a set of topologic equations, expressing both the topology and logic of the network, in computer language. (Topology involves the geometric aspects of the network; that is, the position of each component and its relation to other components.)

The general-purpose computer then used these to produce sheets of instructions specifying the number of modular logic packages in a subassembly.

The instructions also specified the pins to be interconnected, the size and length of wire to be used in connecting them, and the wire paths to be followed for minimum path length. Any special-purpose logic packages to be used in a subassembly were also specified.

After the wiring-information sheets were completed, a complete parts list including logic packages, externally wired resistors and capacitors, and necessary wire was prepared.

Gas-Turbine Specifications

THE entire January-February, 1961, issue of the bimonthly *Gas Turbine* is devoted to a listing of 274 models of gas turbines made by 46 manufacturers in nine countries. Turbines of all types and sizes are available—from the 56,300-hp unit built by DeLaval Ljungstrom to the 70-lb-thrust unit built by Williams Research Corp.

Eight companies list only one turbine model while 10 companies list 10 or more. General Electric has 26.

Checking rated fuel consumptions, large-turbine rates range from 0.40 lb per hp-hr, up. Best fuel consumption listed (at 60-F amb) for a jet unit is 0.72 lb per lbt hr; for a turbofan, 0.50 lb per lbt hr; and for the turboprop is 0.46 lb per ehp-hr. Among automotive-type units, Chrysler's quoted consumption of 0.51 lb per hp-hr (at 85-F amb) is the lowest in the listing.

Reprints are available at $1 each for 1 to 10 copies, somewhat less for larger quantities, from Gas Turbine Publications, 80 Lincoln Ave., Stamford, Conn.

Prestressed-Concrete Conveyer

A MATERIALS-HANDLING system that uses prestressed-concrete channels as the conveyer support has been developed by the Frank J. Madison Company of San Francisco, Calif. In the unique design, on which patents are pending, the U-shaped beams are inverted so as to also serve as a protective cover for the belt, drive, idlers, and the material being handled.

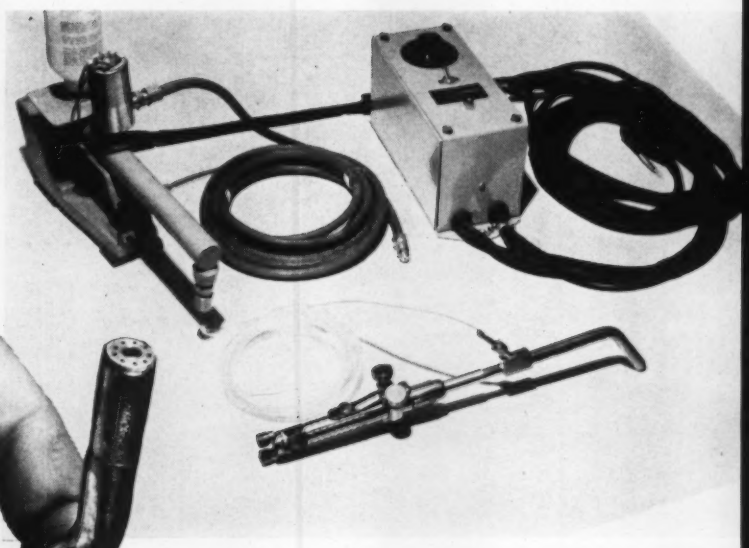
Lower initial cost is cited as the chief advantage of the prestressed construction. Inserts for idler attachment are integrally cast in the channels, eliminating the need for steel hangers. Supporting piers and change-overs may be precast or cast in place and no steel structurals are required. Comparative studies for the first installation, a 1½-mile conveyer at a large Western industrial plant, indicated savings of 40 per cent over steel.

Maintenance costs are also lowered because of freedom from weathering and the ease of servicing made possible by inspection ports at each idler. Permanence in any environment may be expected from the design, the use of concrete being especially advantageous near the sea and in other corrosive atmospheres.

Attractive appearance is also important where installation is made on highways or near private lands.

Prestressed-concrete U-shaped beams serve both as protective cover and conveyer support to provide lower cost and decreased maintenance for a materials-handling conveyer

Powdered metals are simultaneously sprayed on a base metal by means of an oxyacetylene flame in the Aircospray Process. At upper left in **photo at right** is the exclusive powder dispenser, while the rheostat is at right. The modified torch tip, **below,** makes it possible to feed powdered metals into the center of oxyacetylene flames in brazing and hard-facing operations. Separate channels within the tip for carrying fuel gas and powdered metals eliminate flashback.



Metal-to-Metal Surfacing

POWDERED metals can be sprayed and fused simultaneously on a base metal by means of an oxyacetylene flame with an Aircospray introduced by Air Reduction Company, Inc. Separate baking, or heating with a torch, was formerly required if fusion was desired. The fineness and uniform emission of the powdered metals available with Aircospray makes possible depositions as little as 0.003 in. in thickness.

The process is particularly well suited for hard facing operations—including deposition of powdered metals with a high melting point on a base metal of lower melting point—since alloys of greater hardness can be compounded in powdered form than in standard rod form. It can be utilized on such parts as pistons, valves, saw-blade guides, and any other sliding surfaces on engines, pumps, and similar machinery. Aircospray works ideally whether depositing bands of surfacing on thin and light members or on heavier sections.

When used with phosphorus or silver filler metals, Aircospray gives true capillary brazing (deep penetration), and permits placement of the filler metal, combined with flux, directly on the joint area.

Basic element of the new process is a standard oxyacetylene welding outfit with a modified torch tip which permits the powdered metals to be sprayed through the oxyacetylene flame. A carrier-gas source, a means of dispensing and carrying the powdered metals to the torch tip, and the necessary controls are also provided. The carrier gas may be argon, helium, nitrogen, or carbon dioxide. The fuel gas that is used can be either acetylene or natural gas.

For Sensitive Noses

TODAY, odor is a dominant factor in determining the sale of a number of products, and a multimillion-dollar industry, involving tons of aromatic substances, has been built up.

The volume far exceeds that of the perfumes produced for milady's toilet. Neutralization—reacting a material of undersirable odor with another material to produce something with no odor—is the ideal solution to odor problems, according to the November, 1960, *Industrial Bulletin* of Arthur D. Little, Inc. For example, when chlorophyllins are added to some of the malodorous sulfides, there is a definite neutralizing effect. But masking or substitution—covering an undesirable odor with a desirable one—has proved to be more practical than neutralization.

Masking may be used to add appropriate qualities to end products. This practice is widespread in the plastics industry. Vinyl shower curtains, tablecloths, baby pants, and many other products are treated with masks to prevent unpleasant odors from becoming apparent. Natural-rubber products, such as shoe components, carpet and upholstery backings, and rubber cement also require masking odorants of various types. On the other hand, some new interior paints and floor waxes are essentially odor-free. They are a boon to the hotel business, where fresh paint once prevented rooms from being rented for two or three days.

Most odorants and masks are specially tailored to specific problems For example, bad odors from factories, such as oil refineries and fish-processing plants, often cause neighborhoods to become undersirable for both living and working But selected perfumed chemicals can be added at the base of waste-gas stacks or coated on the insides of stacks, so that the waste material which reaches the air is much less offensive. Within factories, bad odors from machinery or apparatus can be masked—oils used for lubricating high-speed cutting machinery, for example, are often perfumed. The offensive odors and irritation produced by burning diesel fuel can be reduced by adding aromatics, and the character of the odor can be changed by substituting a more pleasant one.

The plastic bags that are now used for packaging, seal in the odor of the contents. A wide variety of perfumed wrappers is scented to identify or suggest the contents of the package. Fragrances are blended from a dry mixture of polyethylene and scent concentrates to result in a perfumed film. And if permission is granted by the Food and Drug Administration, perfumed films may be used in direct contact with food products—formulas that correspond to the aromas of baked goods, chocolate, and orange have already been prepared.

Experimental Gas-Cooled Reactor

THE 22-emw Experimental Gas-Cooled Reactor, EGCR, being built in the Oak Ridge AEC area, was 13 per cent complete on October 1 and on schedule.

Building on British and French experience with gas-cooled reactors, the EGCR will attempt to advance this technology to include the use of UO_2 fuel and operating temperatures compatible with modern steam-plant equipment. In the heat exchangers, steam will be generated and superheated to 900 F and 1300 psi. The conventional steam plant will include a single-pressure, nonreheat steam turbine and a 3600-rpm generator of 29.5 emw gross.

Associated research and development projects will not only solve immediate design problems but seek improved future performance, according to the December, 1960, issue of *Power Reactor Technology*, prepared for the AEC by General Nuclear Engineering Corporation.

The first EGCR fuel will probably be clad with stainless steel although experiments will determine the suitability of ceramics and beryllium, which may have improved operating characteristics. Six 29-in-long fuel assemblies will fill each active fuel channel. Each assembly consists of a cluster of seven clad fuel rods containing slightly enriched UO_2 pellets. Several alternate designs will be used for top and bottom spiders and the intermediate spacers to provide improved coolant flow over the original H shapes.

In-pile tests will determine whether a core of inert material must be added to prevent thermally cracked 95 per cent dense UO_2 pellets from breaking up and falling into the core space. Present indications are that it will be unnecessary.

The large ducts, which carry coolant from the central core-containing pressure vessel to the several smaller heat exchangers used in the production of steam, offer a number of flexibility, leak-tightness, and pressure-drop problems. Four practical solutions appear to be: (*a*) Short-radius mitered ("lobster-back") bends on single large-diameter ducts; (*b*) mitered bends on two or more smaller-diameter ducts in parallel for each heat-exchanger circuit; (*c*) corrugated ducts; (*d*) single large-diameter ducts with three tied expansion bellows in each line of ducting.

For solution (*a*), pipe-bend flexibility and stress distribution have been extrapolated from small-diameter pipes with large thickness-to-diameter ratios and will require experimental validation.

Solution (*b*) provides increased flexibility and exerts smaller thrusts on reactor components but costs more.

The increase of total movement caused by the stretching of corrugations in solution (*c*) must be absorbed in the duct system; significant bending stresses cause a creep problem; and pressure drop over a given length is 8 to 10 times greater than in smooth pipe.

Expansion bellows for solution (*d*) would be highly stressed during operation; however, a full-size prototype bellows joint was tested in connection with the design of Britain's Bradwell plant.

Valve requirements of gas-cooled-reactor systems are also stringent, but Bradwell experience is again available as a guide.

Meltless Copper Refining

THE end of the age-old method of producing copper through melting processes may be signaled by a proposed $23-million plant. Designed to turn low-grade ores into high-quality copper—without a melting step anywhere along the line—the plant would be built in the Philippine Islands.

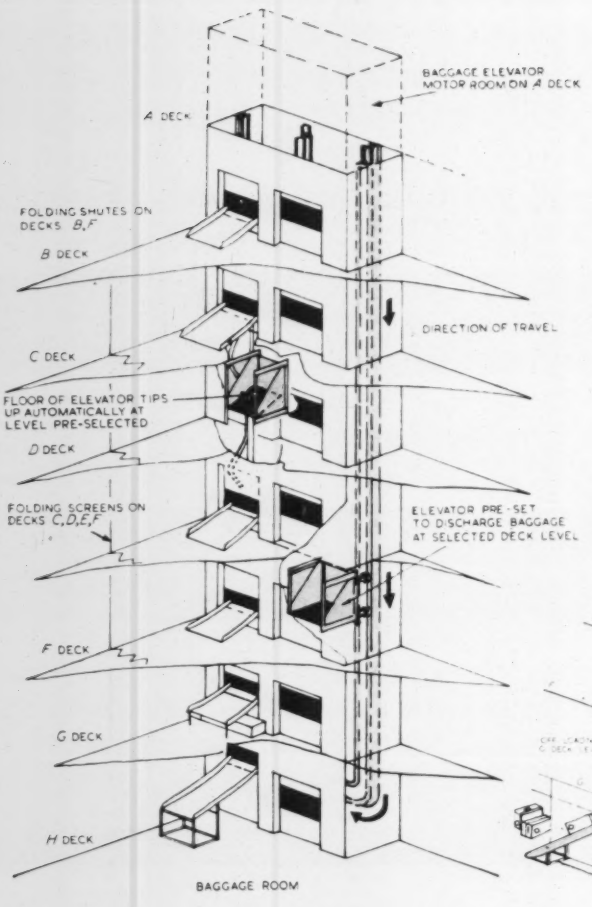
Foster Wheeler Corporation would be prime contractor and the E. W. Bliss Company would furnish its patented rolling and fabricating equipment for converting powder into strip in another portion of the plant which would produce strip, tubing, and wire.

Also scheduled to participate are Chemetals Corporation of New York, 20 per cent of which is owned by the Bliss Company, and Sherritt Gordon Mines, Ltd., of Toronto, which own and license the chemical-reduction techniques.

The Export-Import Bank of Washington has approved a $13-million loan to Marinduque Iron Mines Agents, Inc., for construction of the proposed plant on Iligan Bay on Mindanao Island. This amount, the largest ever made to a private Philippine company, will be matched by Marinduque in pesos. The firm, a leading producer of copper concentrates and other minerals, has been sending 75,000 tons of copper a year to Japan for smelting and fabrication. The funds will be used to set up the world's first integrated copper, zinc, and ammonium-sulfate plant, which will change ores into finished copper products by chemical leaching, gaseous reduction, and newly developed rolling methods. It is expected to save $10 million or more annually for the Philippine economy in foreign exchange and provide employment for 1000 persons.

The capital cost of the installation to produce high-purity copper is 40 per cent less than conventional smelting, refining, and casting plants, and the capital cost of facilities to produce strip and tubing from copper powder is at least 50 per cent less than for conventional fabricating techniques, starting from cake, ingot, or billets.

The process makes it possible to get high-grade copper products from any starting material currently used by the copper industry. It can also handle complex ores, such as copper-zinc combinations, more effectively than conventional methods.

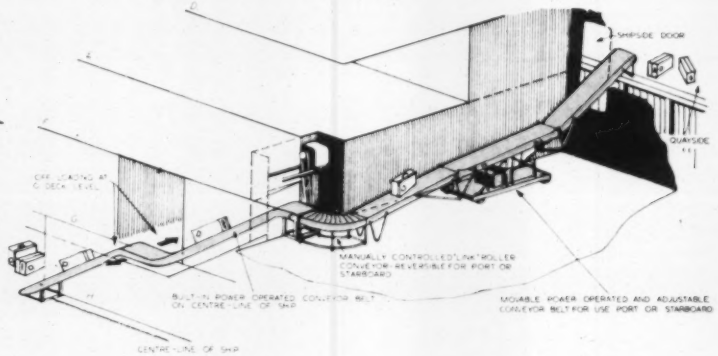


and supported at the other end by castors on the quay. These slat conveyers are 2 ft 3 in. wide and are driven by electric motors at 70 fpm. The slats are covered with replaceable Neoprene to prevent baggage and crates from slipping at gradients up to about 30 deg. All conveyers are reversible and designed for a capacity of 14 articles per minute. When not in use, they are stowed amidships with the boom and jibs shackled to the underside of the next deck. Baggage and stores are taken from the conveyers to storage rooms or to any required deck by means of endless chain elevators on each side of the ship, the loading steward preselecting the deck required by push-button control. If an oversize piece of luggage is put on the conveyer, one of two safety devices operates.

Further details are given in the January, 1961, issue of the British journal, *Mechanical Handling*.

The after system includes preselective push-button-

Carriers attached to endless chains on adapted industrial selective-type elevators and a system of conveyers transport baggage onto a new ship and to the different deck levels


SHIPSIDE DOOR
QUAYSIDE
MANUALLY CONTROLLED LINK TROLLER CONVEYOR REVERSIBLE FOR PORT OR STARBOARD
MOVABLE POWER OPERATED AND ADJUSTABLE CONVEYOR BELT FOR USE PORT OR STARBOARD
CENTRE LINE OF SHIP

Handling Ship's Baggage

BAGGAGE handling will be mechanized on the *SS Oriana*, the largest passenger ship ever to be launched in England. Built by Vickers-Armstrong (Shipbuilders), Ltd., for the Orient Steam Navigation Company, Ltd., the ship will carry 3100 passengers and crew on the Suez route to Australia and will also be used in the Pacific.

According to an article on the *Oriana* in the December, 1960, issue of the British journal, *The Marine Architect and Naval Engineer*, a completely automatic system of loading and unloading baggage and stores from quay to various parts of the ship has been installed, and makes the *Oriana* completely independent of shore installations for the handling of baggage and stores for passengers and crew, supplanting the traditional methods of manhandling or nets or cranes. The system, designed and produced by Sovex Ltd. of Erith, Kent, is based on two conveyers located fore and aft on F deck, each with a 24-ft central boom and two 16-ft 6-in. pivoted jibs. When in port these are moved to port or starboard as required, with one end resting on the quay and the other inside the ship aligned with conveyers down the center of the vessel. The conveyers are in three sections, each of which can be separately adjusted by a hydraulic system to suit the relative heights of deck and quay.

At certain ports, tidal conditions necessitate the use of a short, power-driven extension conveyer which is supported at one end by hinging to the transverse conveyer

type elevators which transport baggage from decks B to H, inclusive.

The elevators are adapted from a standard Sovex industrial selective type and are situated aft and to either side of the ship's center line to serve decks B to H.

Carrier trays measuring 4 ft 6 in. wide by 2 ft deep are corner-hung between two chains of 7-in. pitch in such a way that carriers remain horizontal as they pass between the driving sockets at the top of the elevator and around the tension sprockets at the foot. Within the framework of each carrier is pivoted a tray with back and part sides which, on being released by the selector mechanism, tilts forward to allow its contents to slide out on the deck.

The carriers are attached to endless chains at 10-ft pitch and the trays will carry loads measuring up to $4 \times 2 \times 2$ ft and weighing up to 100 lb. A 5-hp motor drives the elevator through a reduction gearbox at a speed of 40 fpm, so that, except when stopping to load extra-large or heavy items, four trays per minute are presented to each deck's loading and discharge positions.

Any empty carrier can be loaded at any deck and controlled automatically so that it discharges its load at a preselected deck. As an empty tray approaches a loading position the operator loads a piece of baggage while the tray continues to move, and presses one of a series of push buttons which are located on the framework of each carrier, and move with the tray. The baggage then travels on its way and is discharged automatically at the appropriate preselected position.

Three-Station Transfer-matic

To AUTOMATICALLY precision face the ends of transmission cases requires a machine tool that is extremely sensitive and, at the same time, heavy and rugged enough to handle irregularly shaped parts. The Cross Company, Detroit, Mich., has recently designed and built a three-station Transfer-matic that is as unusual in its materials-handling concept as it is accurate in operation. It holds flywheel-housing and transmission-extension mounting faces parallel and flat within 0.003-in. true indicator reading and square with the main bore within 0.0035-in. true indicator reading of a 3.5-in. radius. In addition, specifications call for a surface finish of 175 microin. which must be maintained despite the interrupted cuts on both ends.

In operation, three transmission cases are manually placed in the loading station with the shifter-rod holes down and the cover face to the left. A lift-and-carry transfer mechanism is used to transfer the parts from the loading station to the machining station, three at a time. In the machining station, the headstock advances and positions the driving arbors inside of the main bores of the transmission cases. A special mechanism positions the parts axially so that the dimension from the end face to the center line of the shifter hole is maintained.

The drive arbors then expand in the main bores to clamp the parts, and the tailstock centers advanced while the transfer bars lower away. The main drive motor then starts the rotation of the drive spindles and the single-point tools feed across the end faces. When the cuts are finished, the main-drive spindles are stopped and the transmissions are positioned with the cover faces down. The arbors then release the parts, the transfer bar raises, the arbor and the tailstock centers withdraw, and the parts are transferred to the unload station where they are automatically removed with a special material-handling device.

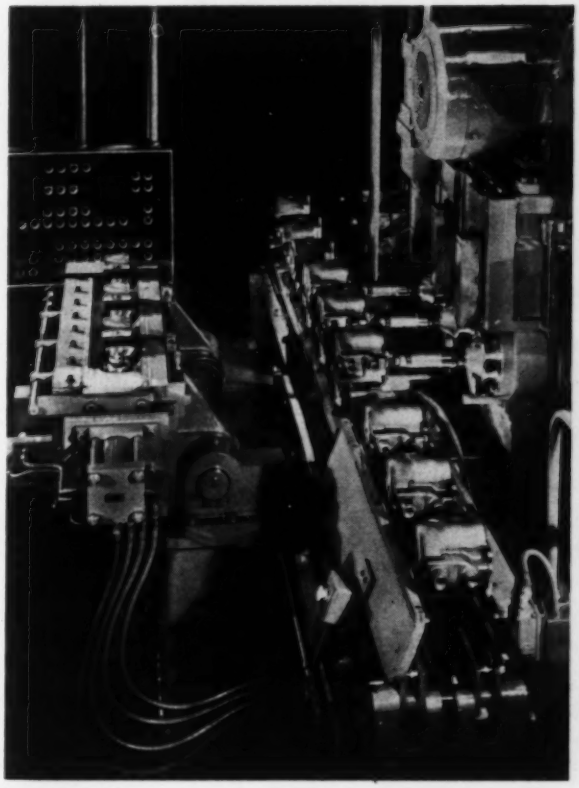
The high accuracy achieved by this Transfer-matic results from: (*a*) Rotation of the parts on the axis of the main bore; (*b*) the driving arbor which precisely centers the part without distorting it; (*c*) the balancing arrangement of the drive spindles; (*d*) a variable-speed drive that provides a constant cutting speed as the diameter of the cut changes.

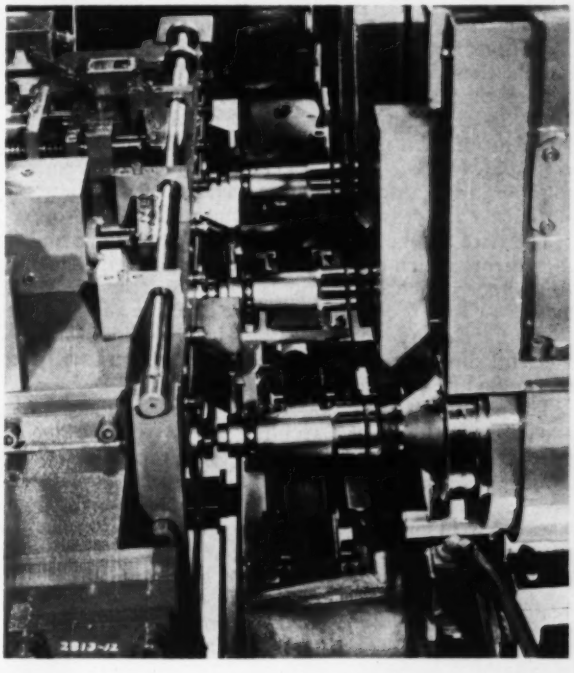
To keep cutting speed constant as the tools feed from the largest diameter to the smallest, this machine is designed with a variable tool feed and a variable-speed d-c drive motor having a base speed of 850 rpm.

This Transfer-matic picks up parts in one attitude and unloads them in another because of an unusual spindle-positioning device which is tied in with the stopping mechanism.

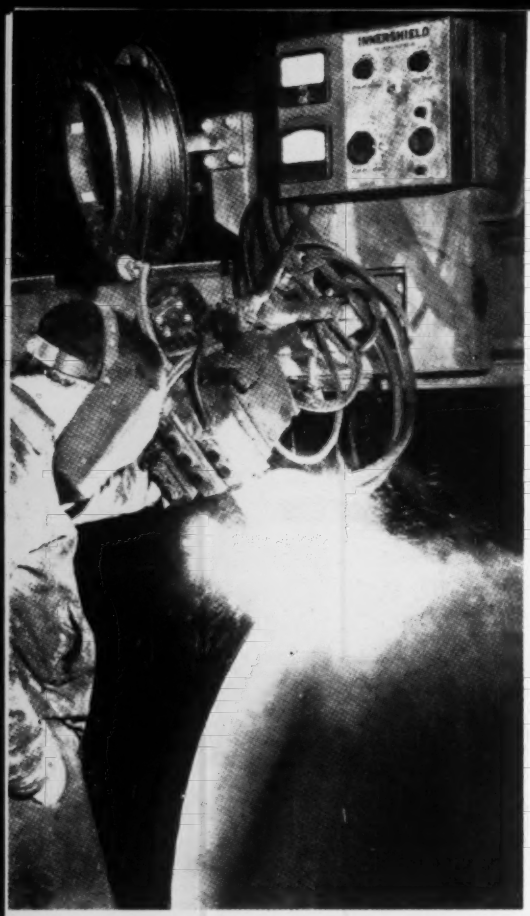
This unusual part-orientation technique is provided to accommodate the automatic unloading requirements. The complete machine cycle is 67 sec, giving production of about 130 cases per hour at 80 per cent efficiency.

Although this Transfer-matic is a little brother to the early transfer machines, it illustrates how many of the advantages of the larger machines can now be applied in special-purpose machine tools with more restricted requirements. Not only can transfer-machine design techniques be scaled down to meet particular part and production needs, but automatic materials handling—inherent in transfer machines—can be incorporated in the smaller machines to meet the necessary process requirements.





Brazed-carbide tools can be removed easily from a three-station Transfer-matic machine tool when the slide is tilted up, **as above.** The expanding arbors and their outboard supports are visible when the workpieces are removed from the three-position work station, **below.** Speed and feed controls are visible at left. One of the spindle counterweights is located directly under the head end of the arbor



No external shielding medium is needed to protect arc area in the vapor-shielding welding process since the part rotates under welding heads

Vapor-Shielded Arc Welding

A FULLY automatic vapor-shielded arc-welding process which operates at 150 to 200 ipm on light-gage metals has been developed to the point where commercial installations have been made. Although these speeds are double those of the submerged-arc, laboratory studies confirm the feasibility of even higher speeds.

As described in an article by R. A. Wilson, vice-president of the Lincoln Electric Company, in the January, 1961, *Welding Journal*, a cored bare electrode is used to provide a vaporized shield, and a clean surface for good electrical contact is the basic element of the new process.

The wire is tubular, filled with granular and chemical ingredients which boil in the arc heat and then condense to a vapor which both shields and deoxidizes the weld metal. Vapor proves to be a more effective and efficient shielding medium than a gas. The tubular form provides fill shielding and deoxidizing without the addition of external flux or gas.

The process also meets or exceeds present cost and speed standards for automatic welding and provides required physical properties. The fast-follow arc action means that the molten weld puddle follows close to the arc and can be moved along the plate at exceptionally high speeds. While the arc is penetrating, it has less tendency to burn through at a given current than with small-diameter gas-shielded electrodes.

Constant wire feed is provided in the automatic head.

A major automobile manufacturer has adapted the vapor-shielded welding process to advantage in the fabrication of stamped axle housings. Applications include welding a reinforcing head inside the housing butt-joint seam, welding the flanges to the ends of the housing, and welding on the dust cap at the center opening. Speed averages around 150 ipm on all three welds.

Flange and dust-cap welders are converted submerged-arc fixtures, with few alterations beyond installing the new welding heads and controls. Welding the reinforcing bead is a new operation and requires a new fixture.

One of the chief reasons for changing from the submerged-arc technique was the elimination of large quantities of dust arising from the granular flux. This material, which was abrasive in character, caused occasional down-time production loss for maintenance of the automated equipment.

The new welding process has improved the quality of joints and has made a notable decrease in the number of "repairs." Porosity may, for example, be encountered on the flange joint because of unusual fitup conditions or some foreign material in the joint. It is an easy matter to continue the weld for two revolutions to eliminate this problem and thereby insure a pressure-tight weld. When two passes are made, speed is increased and over-all time is about the same.

High-speed welding, without flux or separate supply of shielding gas, has also brought noteworthy quality and economy to the production of glass-lined and galvanized-steel water-heating tanks.

Vapor shielding also shows advantages in both speed and distortion control in the welding of lightweight beams—especially tapered beams—used in various types of prefabricated buildings made by United Steel Fabricators, Wooster, Ohio.

Electric Auto-Lite of Toledo, Ohio, uses the vapor-shielded process to make both extremely long and very short welds. Tubing for starter and generator frames is welded continuously for 74 min. A spot weld is made in 1 sec.

The vapor-shielded automatic process is ideally suited to round parts that can be fabricated on a rotating positioner. Thus opportunities are virtually unlimited. Its welding speed usually will be double that of the submerged-arc process on the same part, giving substantially reduced labor costs and a much faster turnover of production. Long, straight joints also show increased speed, partly because of less tendency to burn through.

Adhesively Bonded Structures

PUMP assemblies, rotor blades, honeycomb-core structures, and metal clips for attachments and mountings are being bonded with high-strength structural adhesives.

According to an article by E. F. Hess, of Minnesota-Mining and Manufacturing Company, in the January 5, 1961, *Machine Design*, there are a number of advantages to adhesive joints: (*a*) Because adhesives form continuous bonds, stress loads are distributed over the entire joined area; (*b*) sealing and bonding are performed in a single operation; (*c*) the flexible bond damps or absorbs vibrations, reducing fatigue stress in metal parts; (*d*) adhesives act as continuous barriers between dissimilar metals; (*e*) there are no gaps, bulges, external projections, or surface mars; (*f*) structural soundness is unimpaired because drilling and countersinking of parts are unnecessary.

Among the general-purpose structural adhesives, the

elastomeric phenolics and modified epoxies have assumed a dominant position. Although both are high-strength adhesives, properties and application methods of each type differ and must be matched to the job requirements.

The joint should be designed to take full advantage of the adhesive's properties. Adhesives seldom display the best properties when substituted directly for other fastenings.

Elastomeric-Phenolic Adhesives. Thermosetting films of the elastomeric-phenolic type are made in continuous form in thicknesses from 0.003 to 0.010 in. The film is rolled on a nonadhering liner and remains stable for long periods when properly stored.

Film adhesives provide uniform adhesive thickness throughout the joint and controlled confinement of adhesive to the immediate bonding area. Application and curing procedures are simple, since film adhesives do not contain solvents.

Film-type adhesives offer the best compromise of shear strength, peel strength, shock, and fatigue resistance. They adhere well to metals and plastics and offer flexibility, impact strength, and vibration absorption.

Some film adhesives can be used for high-strength bonding applications at temperatures as low as −80 F; others can withstand moderate stress at 600 F for short periods.

Thermosetting adhesives require both heat and pressure to produce the bond. Pressure is needed to bring the metal parts into contact and to contain volatile by-products given off during the curing reaction. If pressure is not maintained during the cure, the vapors cause a porous bond.

Bonding pressure should be applied uniformly before the temperature of the bond line reaches 180 F. This pressure causes the adhesive to flow, to wet the surfaces, and to fill small mismatched areas. A bonding pressure of 25 to 150 psi is required, depending on the rate of heat input to the bond line, composition of the adhesive, and thickness of the metals being joined.

The gradual application of heat produces many changes in elastomeric-phenolic film adhesives. The film can be heat-tacked in place at 160 to 180 F, and becomes thermoplastic and wets the adherend between 180 and 210 F. Cross-linking or polymerization begins between 220 and 250 F and is completed with toughness developed between 325 and 350 F. Various strengths can be produced depending on temperature and length of cure.

Modified-Epoxy Adhesives. Available in a two-part, room-temperature-curing type, RT, and a one-part heat-curing type, modified-epoxy adhesives offer high strength, resistance to creep under constant stress, and exceptional adhesion to most surfaces.

Modified-epoxy adhesives are self-filleting and are used in honeycomb-sandwich construction. Because no gaseous by-products are given off during the cycle, they are excellent choices for bonding impervious surfaces. Since the consistency of modified-epoxy adhesives is about that of paste, they have fair void-filling properties and can be used for structural joining of loosely fitting parts. These adhesives require only contact pressure during the cure.

Single-component modified-epoxy-resin adhesives contain a latent hardener that is activated by the temperature of the curing cycle. This type of adhesive has an unlimited working life, unlike the two-component type. Although the recommended curing cycle is 1 hr at 350 F, exposure to higher temperatures can reduce curing time considerably.

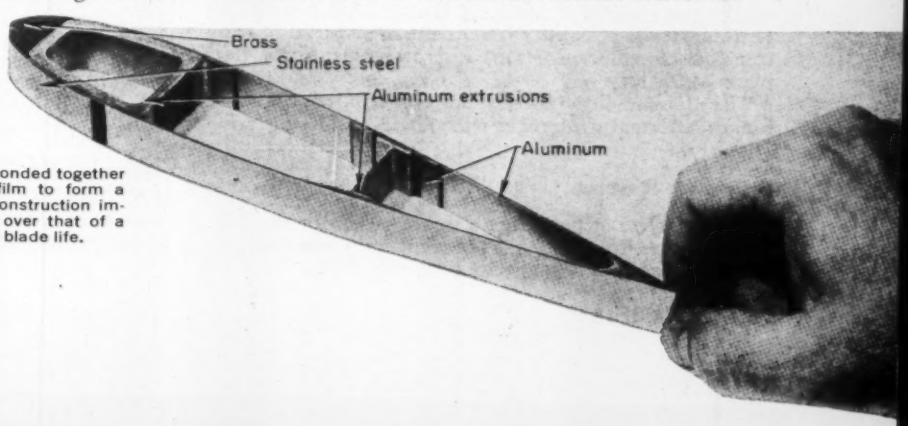
Two-component modified-epoxy adhesives consist of a base resin and a separate liquid catalyst or curing agent. The two materials are mixed immediately prior to their use. As soon as the components are mixed, the curing reaction begins, slowly at first, then more rapidly. Heat accelerates the cure, and since the chemical reaction is exothermic (produces heat), the temperature must be kept relatively low by limiting the size of the mixed batch, by cooling it artificially, or by spreading it on a flat surface to dissipate the heat. These methods prolong the working life of the mixture considerably.

Two-component modified-epoxy systems cure at room temperature in about seven days. They are used for bonding in applications where facilities for heat or pressure are not available. Curing can be accelerated, however, by heating the assembly in an oven, under infrared lamps, or with dielectric or induction-heating apparatus.

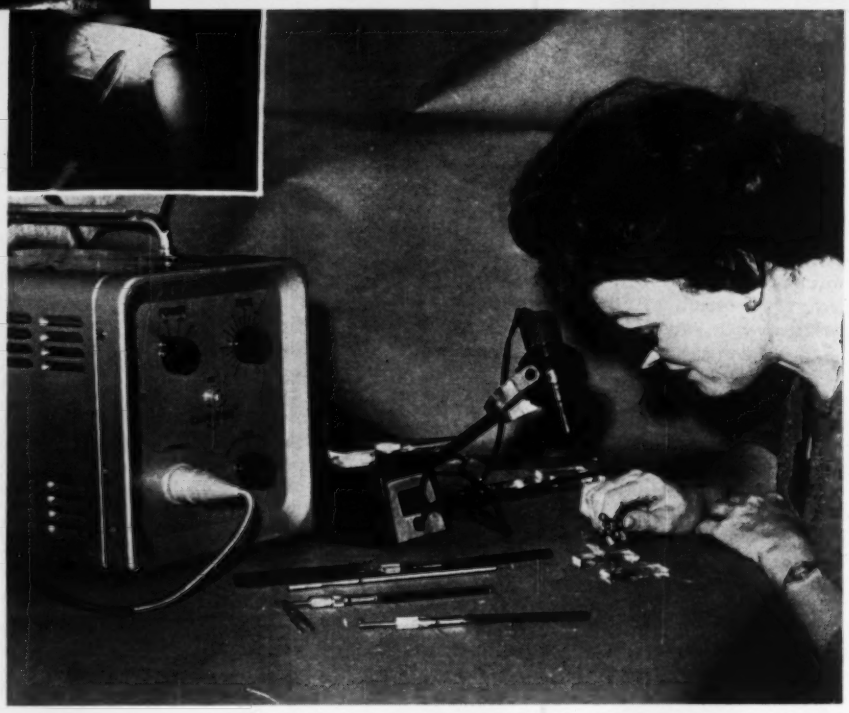
Composite Film Adhesives. Supported composite adhesive films have a high-strength, peel-resistant adhesive film on one surface and a self-filleting adhesive film on the other. These films provide high peel strength and beam-shear strength for applications to honeycomb-sandwich construction. The peel-resistant adhesive (elastomeric phenolic) bonds to the facing, and the self-filleting adhesive (modified epoxy) bonds to the core of the honeycomb-sandwich panel. This arrangement provides high-strength properties at service temperatures from −70 to +250 F.

Aluminum honeycomb-sandwich panels of this construction have beam-flexure strengths of 1580, 1530, and 1385 psi at temperatures of −67, +80, and +180 F, respectively, when tested per MIL-C-7438B specification. Peel strengths (climbing-drum method) of these panels are 18, 24, and 21 lb per in. of width at the same test temperatures.

Because composite-film adhesives do not require priming of the honeycomb-sandwich core, weight of finished panels is kept to a minimum. For the same reason, fabrication costs of this construction are attractive.



Three different metals are bonded together with heat-cured adhesive film to form a rotor blade. The bonded construction improves vibration resistance over that of a riveted blade, and increases blade life.



Ultrasonic microjoining including heatless welding and fluxless soldering can be accomplished with a single versatile kit. The vibrating table with plain metal rod for working it, **upper photo;** a tweezer insert, and a spot-welding insert can be used interchangeably in the multipurpose tool. The large instrument is the ultrasonic generator, and the ultrasonic transducer is in the handpiece.

Ultrasonic Microjoining

Ultrasonic microjoining, including heatless welding and fluxless soldering, can be accomplished with a single versatile kit made by the Cavitron Corporation, Long Island City, N. Y. The table-sized unit with interchangeable handpieces will weld leads as fine as 0.0001 in. in diam.

An ultrasonic-transducer handpiece and four basic inserts with additional tips to be added to the line make possible virtually any microjoining operation. The equipment is able to perform a variety of joining operations impossible or extremely difficult with other equipment: (*a*) Welding gold wire as fine as 0.0004 in. in diam, (*b*) welding CP nickel leads of 0.002 in. in diam, (*c*) soldering gold wire on gold-plated silicon and on 0.003-in. aluminum foil, (*d*) joining 0.0015-in. gold-galium alloy, (*e*) welding 0.001-in. copper-plated nickel alloy with 28 per cent indium.

The company will also market a table-sized generator, although any suitable generator can be used.

Although designed for research laboratories, the kit has demonstrated its adaptability to production problems. The initial set of inserts includes attachments for tweezer welds, a ball-modification of the tweezer insert, a spot-welding insert, and a vibrating table. A wheelhead for seam welding will be optional.

Cavitron will design custom inserts for the kits to user's specifications. The standard line will be enlarged to use 10 inserts in the future and will include special attachments for the welding of plastics. Microsoldering without flux is possible with the use of a special heating transformer, soldering iron, and attachments for hot-plate soldering.

The ultrasonic cavitational activity removes the oxide film that normally interferes with fluxless soldering.

Spinning Reserve

The problem of designing a steam generator for spinning reserve—that is, as part of a turbine-generator unit for producing peaking capacity by overloading a unit that is already operating, or "spinning," rather than by starting up a reserve unit—was described by C. F. Hawley, Mem. ASME, chief mechanical engineer, Riley Stoker Corporation, Worcester, Mass., in a paper entitled "Steam Generator Design for Spinning Reserve," presented at an ASME Los Angeles Section meeting.

These units are designed to produce a normal efficient capacity and also an overload capability at reduced efficiency. When this is as much as 20 per cent overpressure and 20 to 30 per cent flow increase, it is one of the best prospects for lower incremental kilowatt costs.

The simplest method of increasing turbine capability is to produce more steam flow through the unit, and this usually requires an increase in pressure entering the machine. The designer is faced with the two primary problems of producing more steam and a higher pressure. Efficiency of either the turbine generator or the steam generator at this overload is unimportant as the duration is for a brief period.

The problem of pressure is simple and concerns the strength of the materials and the circulating characteristics of the unit. Drums and tubes must be strong enough to withstand the increased stresses; superheater and reheater material suitably selected; and circulating and steam-releasing circuits checked for adequacy.

Carefully considered compromises in design must be agreed to in advance between the vendor and the user to arrive at an economical answer.

Certain operating characteristics can be tolerated for a short-overload operating condition that would not be countenanced for a continuous situation. These involve high heat-release rates in furnaces; high absorption rates in steam-producing areas; fans and fuel-burning equipment at near-wide-open condition with no reserve margins.

A specific example will clarify this concept. The Riley Stoker Corporation is now building the Conesville No. 3 Boiler for the Columbus and Southern Ohio Electric Company. This has 1,000,000 lb per hr normal capacity with 1,240,000 lb per hr overload capability.

The boiler is designed to operate satisfactorily with a strip-mine Ohio coal containing 10.1 per cent moisture

and 14.1 per cent ash, with an ash-softening temperature of 2050 F and with one pulverizer out of service at the normal load.

At peak load all pulverizers will be in service with little reserve and the fans will operate close to wide open. In fact, the optimum result with the maximum economy is for all the auxiliaries to operate wide open at the overload.

The 17 per cent overload capacity is obtained by increasing the primary steam flow 24 per cent, the pressure 10 per cent, the reheat flow 40 per cent, and reducing the feedwater 154 F by removing top feedwater heaters from service. All of these changes result in a 40 per cent increase of the heat output. Obviously, when burning coal, a 40 per cent increase in furnace duty requires careful attention to furnace design.

The furnace design is liberal with a 160-F differential between furnace-exit-gas and ash-softening temperatures at the normal continuous load, but the differential disappears at the peak.

This can be tolerated at the overload but is not satisfactory as a continuous load. This condition will be controlled by more use of wall deslaggers and furnace-exit blowers during this period. The liberal use of furnace water-wall platens insures minimum deviation from the calculated temperature across the 47-ft width of the furnace. This is important because after an overload the unit is to return to continuous normal capacity with no low-load period to clean the furnace.

In another coal-fired reheat unit designed for 850,000 lb per hr maximum continuous capacity at 1840 psig, 1000/1000 F, five water-wall platens level out the furnace-exit temperatures.

The Columbus design is typical of a spinning-reserve concept for a coal-fired unit. Normal capacity is conservative, but not to the point of increased basic cost, and the overload reserve is within the unit's capabilities—26 mw, equivalent to 17 per cent additional capacity, are obtained with a minimum of additional steam-generator costs.

The steam-generator cost can be designated as X per kilowatt to produce a normal output; the reserve capability by the ratio 1.17; the additional steam-generator cost for the reserve by the ratio 1.05. Obviously, the incremental increased kilowatts are obtained at a cost ratio of $5/17X$ or $0.29X$ per kw instead of X per kw. This is the kind of cost saving that makes this type of unit attractive under today's conditions. Although the steam-generator cost is only a part of the cost, similar savings are obtained in total over-all cost.

Oil or coal firing produces even more attractive results. Since an oil or gas-fired unit eliminates slagging and pulverizer problems, overload capacity is largely a matter of increase in pressure parts, fuel-burning, and fan capacity. The incremental increased cost of steam generation is usually less than for a comparable coal-fired installation.

In a unit where megawatt capability increases 25 per cent, primary-steam flow 25 per cent, pressure 21 per cent, reheat flow 36 per cent, and feedwater decreases 92 F, the incremental kilowatt cost ratio is $0.24X$ per kw. This compares with $0.29X$ per kw for the coal-fired unit and points up the difference between coal and gas firing.

Another interesting method of increasing reheat-unit capability is to increase the steam flow through the reheat end of the turbine without changing the flow through the primary high-pressure end. It will be evident that y pounds of steam flow through the high-pressure end and mix with steam from the primary superheater to pass $1.59y$ lb through the reheater.

This type of peaking unit involves different kinds of design problems which will be evident from study of the requirements. The steam-generator costs show a ratio of $0.25X$ per kw based on the same assumptions used above. This arrangement results in low incremental steam-generator costs. Although the over-all costs are higher, it does give a large increase in capability.

Cost comparisons are given for the various designs. Obviously, these would vary in magnitude with specific studies but are indicative of the relative differences.

Overload Capability as Achieved in Three Different Spinning-Reserve Systems

	Conersville No. 3 Boiler				Gas or oil firing			Bypass peaking cycle		
	Normal	Max. continuous	Peak capacity	Increase over normal	Normal	Peak capacity	Increase over normal	Normal	Peak capacity	Increase over normal
Megawatts	150	156	176	1.17	250	314	1.25	250	350	1.40
Steam throttle flow, lb per hr	1,000,000	1,124,000	1,240,000	1.24	1,715,000	2,139,000	1.25	1,715,000	1,715,000	0
Output per hr, 1000 Btu	1,187,410	1,295,610	1,642,850	1.40	2,013,400	2,614,700	1.30	2,013,400	3,109,100	1.55
Over-all efficiency, per cent	89.70	89.35	88.05	...	85.0	83.5	...	85.0	83.5	...
Superheater-outlet pressure, psig	1508	1589	1670	1.10	2100	2545	1.21	2100	2100	...
temperature, deg F	1005	1005	955	...	1005	955	...	1005	1005	...
Reheat steam, lb per hr	863,000	968,200	1,210,000	1.40	1,559,000	2,130,000	1.36	...	...	...
Reheat steam through turbine, lb	...	...	...	...	...	...	...	1,559,000	2,726,000	...
through reheater, lb	...	...	...	...	...	...	...	1,559,000	2,726,000	[1.75
Steam through bypass, lb	...	...	...	...	...	...	...	0	1026	...
Reheater outlet steam temperature, deg F	1005	1005	1005	...	1005	955	...	1005	1005	...
Reheater inlet steam temperature, deg F	709	750	738	...	681	673	...	681	722	...
steam pressure, psig	472	533	670	...	553	761	...	553	982	...
Feedwater temp., deg F	462	474	308	...	479	387	...	479	460	...
Furnace-exit temp., deg F	1890	1920	2050	...	...	...	...	...	...	...
Furnace heat available, Btu per sq ft per hr	73,200	80,300	105,800	1.44	...	...	...	...	...	...
Furnace heat release, Btu per cu ft per hr	14,550	15,800	20,500	...	...	...	...	...	...	...
Increased steam-generator costs for spinning-reserve capacity	...	...	...	1.05	...	...	1.06	...	...	1.10

Accelerating Flight-Test Programs

FLIGHT-TEST engineers can evaluate data in 2 hr and reschedule another test flight the same day with an ultra-high-speed electronic-data-processing system developed by Republic Aviation Corporation. Previously, two weeks were required before adjustments could be made and another test flight scheduled.

An airborne electronic converter samples system-performance data in analog and digital forms and records these on magnetic tape in digital or numerical code. When the aircraft lands, the tape is removed and fed into special electronic equipment that translates and prepares the information for handling by a large-scale computer, such as the IBM 704.

The compact new flight-test system has been designed for installation into the ammunition compartment of a plane. Although it accepts over 100 channels of information, its total size is only $3^1/_2$ cu ft. While it has the capability for use in structural testing, its present role in the testing of a supersonic-fighter-bomber, the F-105D, is in connection with the aircraft's electronics subsystems. These account for almost 35 per cent of the total cost of the airplane, and include some seven robot "brains" that give the jet an automatic, all-weather capability. A pilot can take off in any kind of weather, fly to his target, unleash a conventional or thermonuclear weapon, and escape the blast safely, all simply by pushing the buttons that set the automatic units into action. Air Force requirements call for the testing of these units on an over-all basis of how well they perform together as an integrated weapons system. The high channel capacity which exists in the new data-acquisition system makes this possible.

Sewaren No. 5

A 342-MW turbine generator being added as Unit 5 at the Public Service Electric and Gas Company of New Jersey's Sewaren plant will be completely controlled by a Prodac digital-computer system designed by Westinghouse Electric Corporation for power-plant automation. Some of the details are given in the January, 1961, *Westinghouse Engineer*.

The purpose of the new computer system is threefold: (*a*) Plant reliability can be improved—hundreds of operating variables can be analyzed quickly and preplanned procedures insure operation within design limits at all times; (*b*) safety to personnel and equipment is insured—high-speed monitoring and preplanned precise control eliminate hurried decisions and possible errors during the stress of emergencies; (*c*) plant efficiency can be improved—up-to-the minute information is provided and the computer continuously adjusts subloop control set point.

Prodac will start, operate, and shut down the entire No. 5 Unit boiler, turbine-generator, and unit auxiliaries—following pre-established programs for both normal and abnormal operating conditions. More than 1000 sensing points throughout the plant—temperatures, pressures, flows, voltages, and currents—will be scanned and converted from analog indications to digital quantities for computer use. Under normal running conditions the computer will also supervise the conventional automatic analog subloops through more than 500 contact-closure inputs and an equal number of outputs. Inputs keep the computer informed of operating positions or condition of components, and contact-closure outputs operate the same devices.

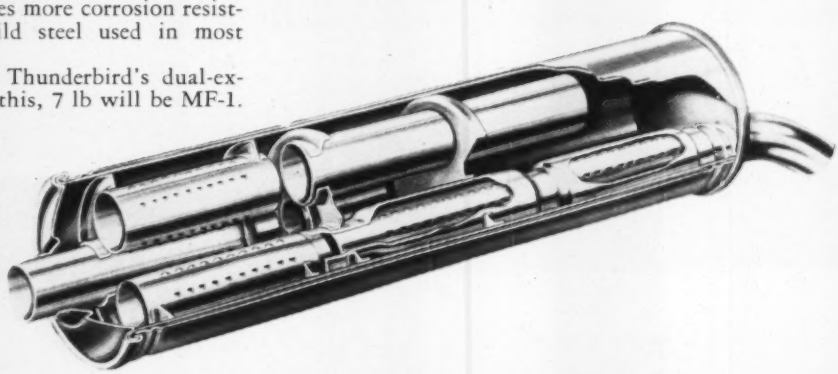
Materials Briefs

▶Stainless-Steel Muffler on Production Car

A MUFFLER with stainless steel used in the critical areas and comprising more than 50 per cent of the total metal is being installed by the Ford Motor Company in the 1961 Thunderbird. It will last at least three times as long as the present standard muffler.

It employs a new steel, called MF-1, developed by Allegheny Ludlum Steel Corporation, which is from five to six times more corrosion-resistant than aluminized steel and from 15 to 18 times more corrosion resistant than the conventional mild steel used in most mufflers.

Each of the mufflers in the Thunderbird's dual-exhaust system weighs 13 lb. Of this, 7 lb will be MF-1.



Two stainless-steel mufflers are used in the dual exhaust system of the 1961 Thunderbird. Each weighs 13 lb, of which 7 lb will be a new MF-1 steel.

▶Lesco BG 42 and BG 43

Lesco BG 42 and BG 43 have been added to Lesco BG 41 to form a new family of bearing steels offering improvements in properties over those of 440-C stainless. The alloys are made by Latrobe Steel Company, Latrobe, Pa. BG 41 was introduced some time ago and replaced the 2 per cent Cr in the 440-C analysis with 4 per cent Mo. BG 42 has 1 per cent V, and BG 43 has 2 per cent. The carbon contents of both are correspondingly higher.

A new adhesive eliminates "explosive" grinding-wheel failure, producing a rubber-to-metal bond that is stronger than the rubber itself

▶ Adhesive Eliminates Grinding-Wheel Failures

"Explosive" failure of rubber-to-metal adhesive is sometimes caused by centrifugal forces at the 19,000-rpm speeds at which some modern polishing and grinding operations are performed. This has been eliminated with a new adhesive.

Chicago Rubber Company, Inc., Waukegan, Ill., uses Chemlok Adhesives 220 and 203, manufactured by Hughson Chemical Company, Erie, Pa., to produce a bond which is stronger than the rubber. The system can be used with a broad spectrum of elastomers and permits wide manufacturing tolerances. One coat of 203 is used as primer and one coat of 220 as adhesive for both stainless-steel and aluminum hubs.

▶ Fibrous Potassium-Titanate Insulation

Exceptional ability to diffuse and reflect infrared radiation is the key to the insulating properties of Tipersul—a new high-temperature insulation material made by E. I. du Pont de Nemours and Company, Inc. Composed of $^{1}/_{16}$-in-long 1-micron-diam crystalline fibers of potassium titanate, it provides an excellent heat barrier in the 1300 to 2200-F range with significant space and weight savings.

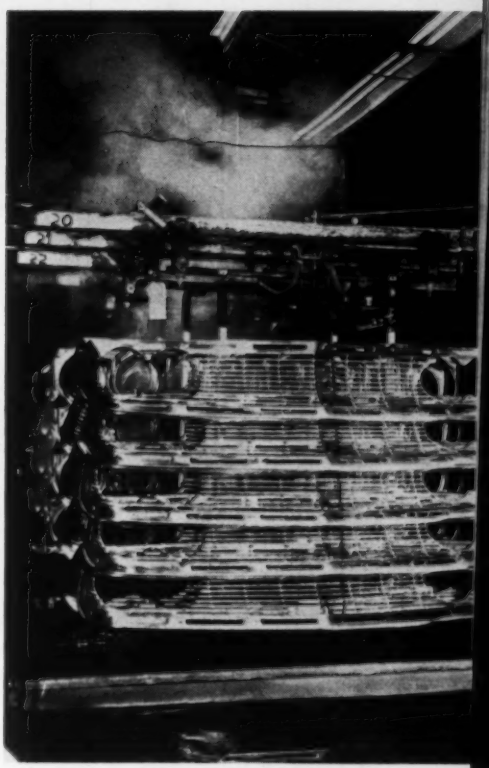
It is supplied in a number of forms including loose fiber that has been fluffed to a density of about 4 lb per cu ft. These are readily converted to blocks or sheets which can be formed or contoured as desired.

Tipersul fibers will withstand vibration and sudden mechanical shock such as dropping, and have proved effective as radiation shields in vacuum systems.

▶ Thermal-Shock-Resistant Glass

Glass that can be raised to 650 F and then plunged into ice water was made and delivered in less than four days for the windshield of the X-15 research plane by Corning Glass Works.

Each aluminosilicate glass panel is slightly trapezoidal in shape, flat, approximately 31 in. long and $8^{1}/_{2}$ in wide, and about $^{3}/_{8}$ in. thick. Specifications for thickness, configuration, and optical characteristics were also surpassed.



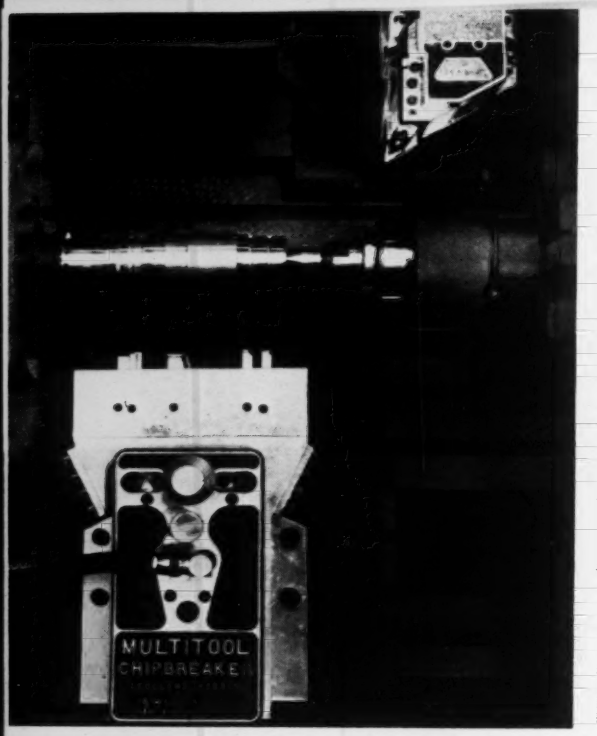
Part of the record use of aluminum in automobiles is accounted for by trim. An average of 10.78 lb of aluminum exterior and interior hardware is used on 1961 models.

▶ Aluminum Use in Autos at New High

The use of aluminum in America's average 1961 automobile totals 62.8 lb, representing a record jump of 15 per cent over last year and the eighth consecutive annual increase. According to an Aluminum Company of America official, the next five years will see aluminum bumpers, wheels, radiators, and rear-axle housings installed on automobiles.

▶ High-Speed Tool Steel

A new grade of high-speed steel, developed by the Crucible Steel Company of America, designated Rex 49, is designed for a two to four-time increase in tool life in machining such hard-to-cut metals as highly alloyed steels, stainless steels, superalloys, and titanium. Rex 49 is claimed to outperform the more expensive high-cobalt and high-vanadium high-speed steels and to eliminate the need for many of the more than 20 special-purpose grades now in use. It can be heat-treated to Rockwell C 67 to 69.



Single and multiple-point chipbreakers arranged for profiling, grooving, and forming. Chips **at left** were made with the chipbreaker in operation, those **at right** without the chipbreaker.

Chipbreaker

A NEW machining device that fragmentizes chips to desired size while lengthening cutting tool life has been developed by Cleveland Hobbing and Machine Company, a Division of Textron, Inc., Cleveland, Ohio.

The device, called the Cleveland Chipbreaker and Tool Booster, also simplifies grooving, plunging, forming, and cutoff; facilitates use and increases life of form tools; reduces tool pressure and heating; increases machine capacity; simplifies size-control problems and improves production output.

The unit was designed for use on lathes, automatics, planers, shapers, and so forth—wherever multiple or single-point tools are used for cutting metal.

The Chipbreaker and Tool Booster operates with a controlled, high-frequency, hydraulically powered, oscillating action which maneuvers the tool-cutting edge against the cut and backs it away for clearing and cooling many times per second.

The frequency of this motion is adjustable from 25 to 200 cps by a dial on the Chipbreakers.

This high-frequency side motion into and away from the cut produces a cleaving action which fragmentizes chips to the desired size as well as reducing heat and wear of the tool bit. Cleveland Chipbreakers work well when cutting any kind of metal from soft, stringy, materials such as copper and aluminum through the range of various types of steels including stainless and exotic materials.

The controlled high-frequency, cleaving action imparted to the tool bit in addition to fragmentizing chips increases the cutting efficiency and reduces the horsepower required for a given cut by as much as 50 per cent.

The substantial increase in cutting efficiency achieved by the controlled high-frequency loading and unloading of the tool bit also means that feeds and speeds can be raised to increase production.

As the oscillating action shears off chips, it tends to wipe off continuous feed marks on its back stroke, and for parts requiring grinding or polishing after turning, grinding time, and wheel-wear at finishing is improved.

The Cleveland Chipbreaker is ideal for grooving, form, or plunge cuts with either single-point or multipoint tooling. The side motion imparted to the tool by the Chipbreaker allows the tool to cut its own side clearance so that bind, chatter, burning are eliminated.

It is also possible by use of the Cleveland Chipbreaker to allow a grooving or form tool to dwell for a few seconds at the bottom of its groove or form without danger of tool breakage, thereby producing more precise, accurate, and chatter-free grooves or plunges.

Status of Reactors

STATUS and operating-experience reports on a number of commercial and experimental reactors were given at the ASME Winter Annual Meeting.

Dresden, in operation since August, and dedicated October 12 (MECHANICAL ENGINEERING, December, 1960, pp. 64–75), which is a 180,000-ekw boiling-water type, has proved very stable and smooth in operation. Some difficulty was experienced with control-rod guide tubes, control-rod drives, and fuel cladding, and additional neutron shielding had to be added at the top. Spring fingers which held fully inserted control rods were bending inward and diverting 10 per cent of coolant flow up through the control-rod slots rather than the fuel bundles. These were welded solid when it was found that they were not needed to hold the guide tubes in place.

Modifications reduced "hammer effect" and other control-rod-drive difficulties. Substitution of 100 stainless-clad fuel assemblies, with thoria enriched in U-235 placed in corner positions, flattened flux distribution across the core assembly. These will be used in place of embrittled zircaloy-clad assemblies.

Yankee, a 135,000-emw closed-cycle light-water reactor, has been undergoing tests since February and achieved criticality in August. Weld tests, hydrostatic tests, instrumentation, and equipment tests have been satisfactorily met except for four defective main-steam-line welds and one field-welded neutron shield tank. In-core instrumentation and control-rod drives have given some trouble. The only effect of a 70-mw load drop has been a 20-deg rise in coolant temperature, although total load drop would probably blow safety valves which might not reseat properly. Present license level of 110 emw was expected to be reached early in December, 1960.

Although construction of Enrico Fermi is essentially complete, it is tied up in legal troubles with the unions. The U. S. Supreme Court will rule this spring and operation cannot begin for three months after that. Nonetheless, criticality is expected next summer. The only commercial power reactor to operate above the thermal range, it will also be the first breeder reactor in that category. Designed for 150,000 ekw, first-core operation will be at 100,000 ekw. Non-nuclear testing was to have been completed in January and both primary and secondary coolant systems would then be complete and the reactor was to be loaded with sodium.

At Indian Point, conventional equipment was 90 per cent complete and nuclear about 80 per cent. Details were given on the training of 22 "cadets," who range from under 21 to over 40 and are all engineering graduates of various types except one. They have had 128 hr on controls, 36 on operation, 22 on reactor-top operations, and 33 hr on loops at NRTS in Idaho. They are now writing the test procedures and operating manual for submission to the AEC.

Reference to personnel licensing was also made in the Yankee report. There, 12 out of 26 passed the AEC written exam and 12 out of 15 the oral (both 6 to 8 hr long). The examinations were termed a challenge to an operator's memory, mental ability, and physical stamina. Companies considering nuclear operation were advised to consider AEC operator-licensing requirements before signing design contracts.

The EBR-II, which went critical in April, is a sodium-cooled reactor which will incorporate continuous fuel processing, performed in an adjacent building. The design has been modified throughout for sodium integrity with a double-walled tank suspended from the top. Breeding gains expected are 1.2 with U, 1.7 with Pu.

Plutonium will also be recycled in a reactor and pilot plant recently completed at Hanford. Fuel-fabrication units—rolling mills, welding equipment, furnaces, and canning equipment—are all hooded and minus-atmosphere protected. Technology will be developed for utilization of plutonium as fuel in thermal heterogeneous reactors. Spectral shift would vary the ratios of D_2O and H_2O in the primary loop to take advantage of their different neutron-capture rates as the long-term effects of fuel burnout and isotope buildup are reflected in core reactivity. The idea has moved from theory to a proposed design for which substantial economies are claimed over ordinary pressurized-water reactors.

One completely new reactor concept, a binary-vapor type which would use sulfur as the primary working fluid, was given theoretical treatment. Thermodynamically it has many advantages. Corrosion and viscosity problems which would be incurred with the sulfur would have to be solved.

Nuclear Briefs

▶Shippingport Operating Experience

THE Shippingport reactor continued to furnish extremely valuable technical and statistical operating information during 1960. Its first seed was removed after 5808 equivalent full-power hours of operation during which 388,500,000 kwhr of electrical energy were produced. The replacement seed, aimed at extending core life, was brought to full-power operation in May. Since that time the reactor has been operating most of the time at full power to develop maximum information on the life expectancy of the UO_2 blanket of the core. At this time the average burn-up in the blanket is 2800 megawatt days per ton of UO_2 which is the highest natural uranium burn-up ever achieved.

This was disclosed by Frank K. Pittman, director of reactor development, U. S. Atomic Energy Commission, in his remarks before the 1960 Annual Conference of the Atomic Industrial Forum in San Francisco, Calif.

The blanket fuel elements' design lifetime of 8000 equivalent full-power hours was achieved on September 9, 1960. Operation through the life of the seed which is now in the reactor will result in approximately 12,500 equivalent full-power hours for the blanket. Examination of some of the more severely exposed blanket elements at the time of installation of the second seed gave reason to believe that the blanket will perform satisfactorily through the third seed which will probably be installed in mid-1961.

The Shippingport reactor has generated approximately 620,350,000 kwhr of electrical energy. During the life of the first seed, the reactor operated at 37 per cent load factor. The load factor with the second seed was of the order of 70 per cent in December.

▶Dresden Shut Down for Control-Rod Modification

"As a conservative measure," the General Electric Company is modifying all 80 control-rod drives in Commonwealth Edison Company's 180-emw boiling-water reactor at Dresden, Ill., according to the January, 1961, *Forum Memo* of the Atomic Industrial Forum, Inc.

Failure of one of the drives had previously been diagnosed as stress-corrosion cracking of the stainless steel used in the drive tube. The same 17-4 PH stainless steel will be used in the modified parts, but with "more recently developed techniques for heat-treatment and quality control." The new drives will be tested under Dresden heat conditions on a test stand and in the reactor before the plant resumes operation.

Similar parts in other G-E reactors at Vallecitos, Calif.; Kahl, W. Germany; and aboard the *N. S. Savannah* will also be replaced.

▶Prestressed-Concrete Pressure Vessel for 375-Emw Reactor

The EDF-3, the third reactor to be built at Chinon by Electricité de France, will have a prestressed-concrete pressure vessel according to the February, 1961, issue of the British journal *Nuclear Engineering*. The 375-emw (present rating) CO_2-cooled reactor will use natural-uranium fuel canned in magnesium-zirconium alloy. There will be four pairs each of inlet and outlet ducts for the coolant, with flow maintained by four circulators.

The plant is scheduled to include two 250-mw turbo-generators to permit an increase in station output to 500 mw even if this is not achieved in the first core.

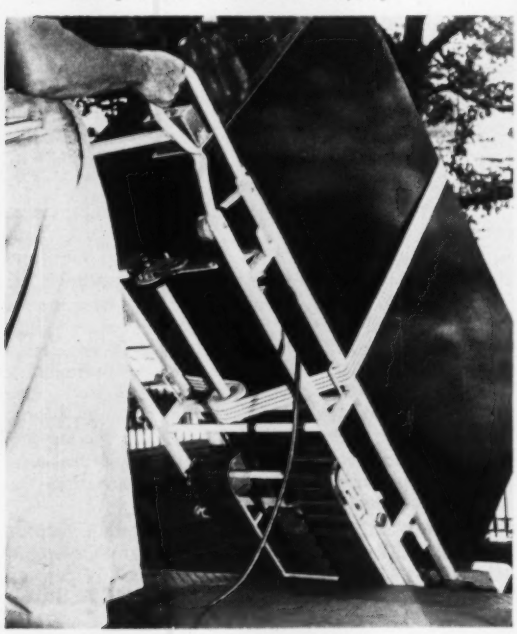
In general (apart from the pressure vessel) the design adopted will more closely resemble that of EDF-2 than G2 or G3. The core is to be vertical, with vertical fuel channels and control rods, and steam will be generated in banks of small unit heat exchangers.

PHOTO BRIEFS

M. BARRANGON

Antenna for Space. That antenna for your space vehicle: It must be light, and packaged in a small space during launch, and then automatically ejected and unfurled. Lockheed designed this antenna balloon, a Mylar sphere with aluminum-foil tubular frame. Pressure in the tubes erects the balloon, which is thereafter self-rigid, though sure to be punctured by micrometeorites.

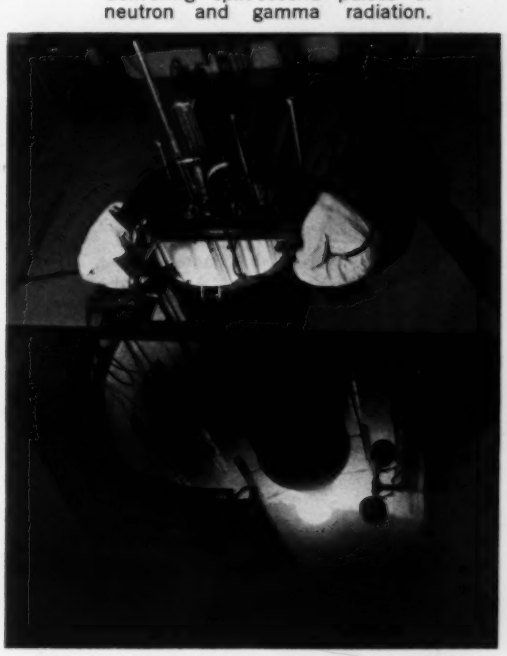
The Stair Cat. On two endless belts, this electrified hand truck simplifies the moving of office equipment, pianos, other large items. It is made by New Design and Development Corporation, of Lima, Ohio, and uses cleated belts from Goodyear Tire and Rubber Company.

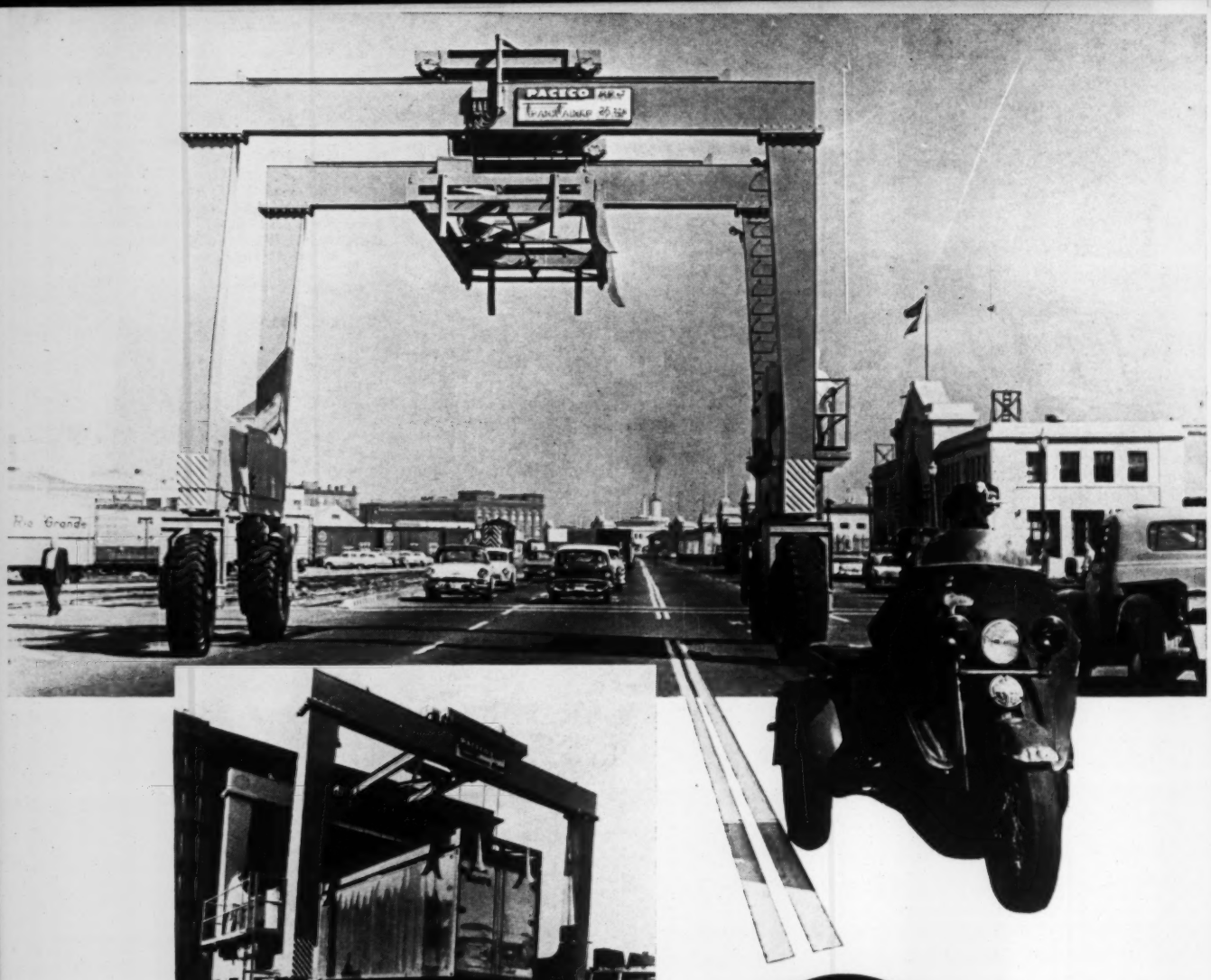


Unsinkable Truck. This lightweight truck has body panels of aluminum sandwich, plus polyurethane foam in the wheel-well sponsons. Designed by Evansville Defense Division of Whirlpool Corporation, St. Joseph, Mich., it can be dropped by parachute and dived into water. It also has water propellers. Carrying capacity, 5000 lb.

Insulation for Frozen Foods. Union Carbide Plastics Company makes the vinyl resin which coats the corrugated aluminum foil of this resilient, noncombustible insulation. Isoflex Company of Burlingame, Calif., produces the insulation, using glass-fiber spacers.

TRIGA. Training Research and Isotope-production reactor General Atomic. The reactor, at General Atomic Division, General Dynamics, San Diego, Calif., simulates effects of radiation in war and space travel, delivering split-second pulses of neutron and gamma radiation.





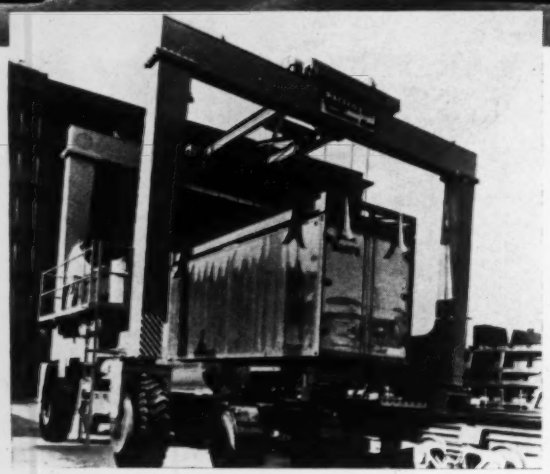
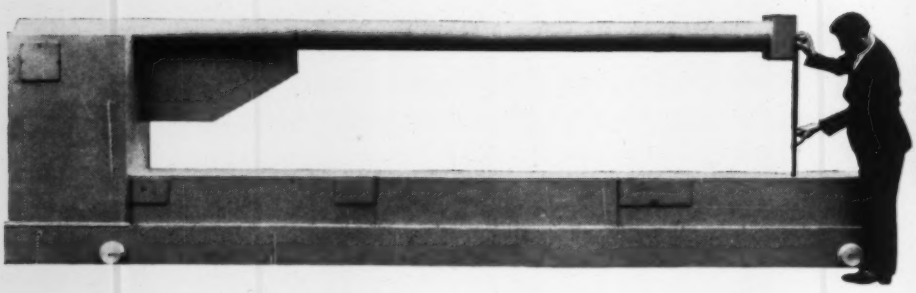


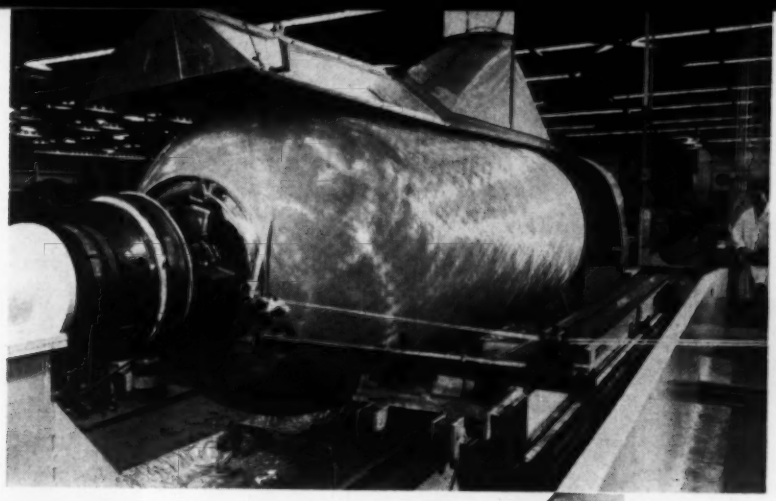
PHOTO BRIEFS

M. BARRANGON

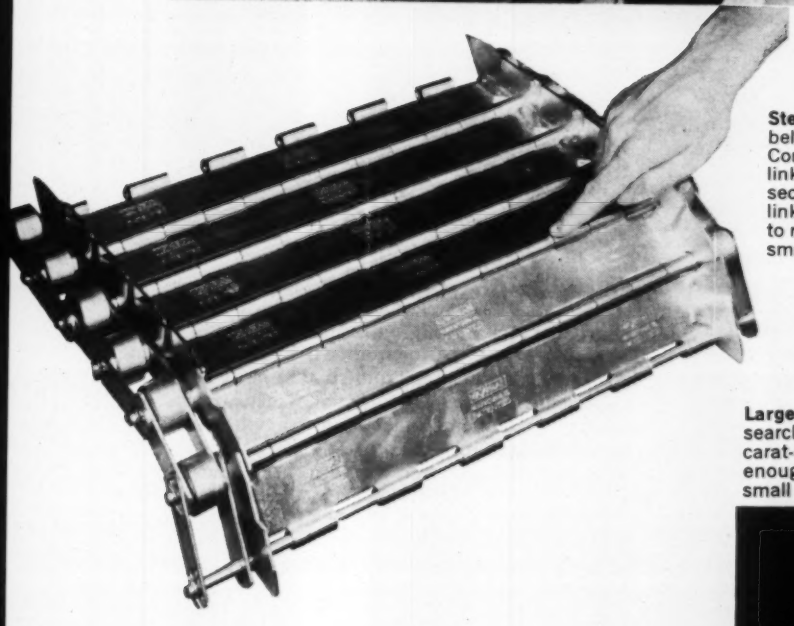
TransTainer. This 24-ft-tall gantry crane, built by the Pacific Coast Engineering Company, rolls on pneumatic rubber tires by B. F. Goodrich. The crane, the first of its kind, spans a railway car and a highway truck at the same time to load and unload containers and piggybacks. A 25-ton cargo container may be transferred from pavement to truck chassis in two minutes. The tires, inflated to 110 psi, may carry a total load weighing up to 70,000 lb.



X-Ray Gage. Weston Instruments Division of Daystrom, Inc., built this x-ray gage to penetrate carbon steel plate up to 2 in. Gap: 30 in. Throat: 160 in.



Spun-Glass Fuel Tank. Boeing Aero-Space Division makes rocket-engine fuel tanks of spun-glass threads, using their own helical filament winding machine. This is an experimental, two-compartment tank, 6 ft in diam, 21 ft long, to hold 3100 gal, and to withstand a pressure of 665 psi. The fibers are bonded together with a plastic resin.



Steel Belting. This hinged-steel conveyer belt, announced by the May-Fran Manufacturing Company of Cleveland, Ohio, has short-pitch links to permit reduction in the over-all section depth. Made of $^1/_8$-in-thick steel, each link has a $2^1/_2$-in. pitch, allowing the belt to run on sprockets with a pitch diam as small as 5 in. For small but heavy loads.

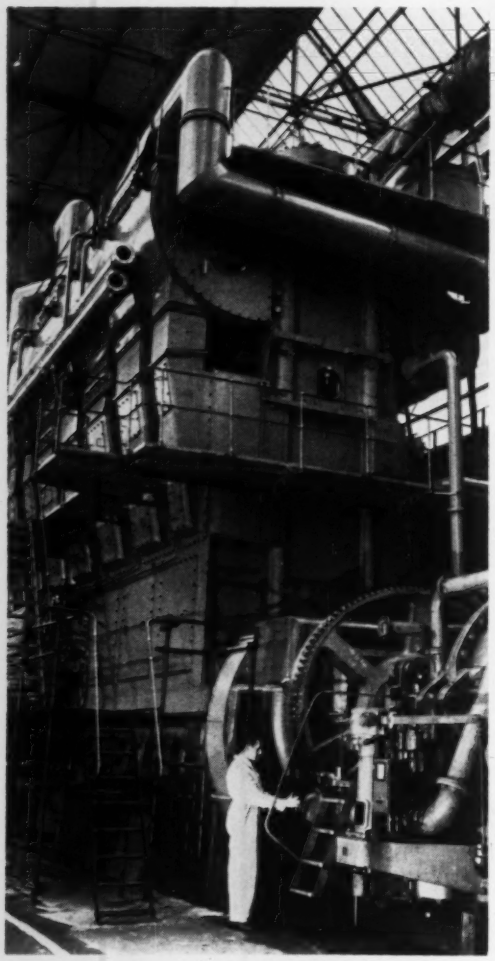
Large Man-Made Diamonds. At the General Electric Research Laboratories in Schenectady, N. Y., they've made carat-sized diamonds—dark in color, and not yet strong enough for industrial applications. That mound is of small GE diamonds for cutting, grinding, and polishing.

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

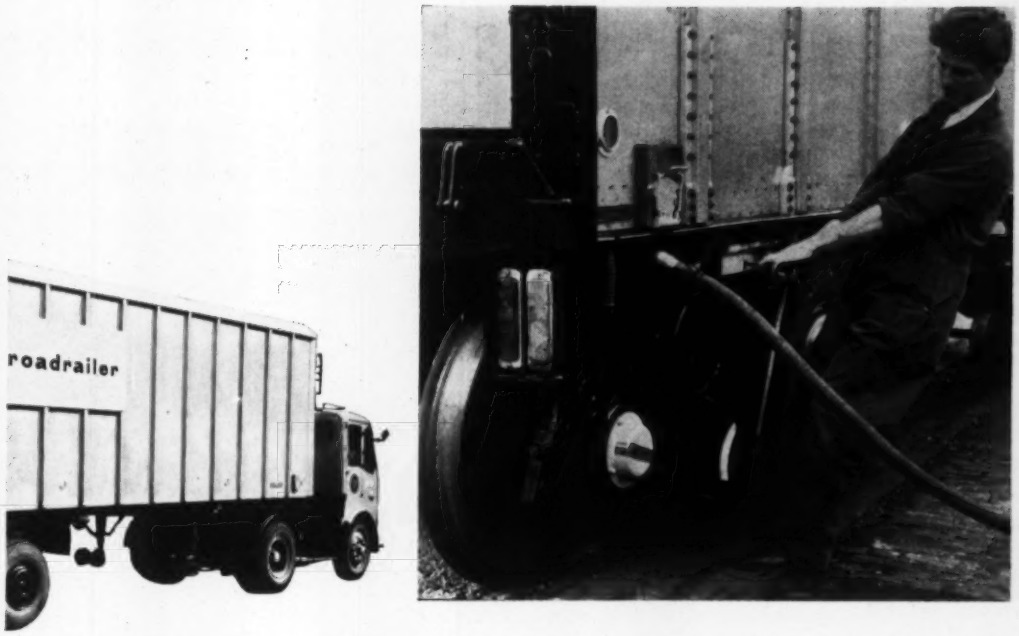
The FIAT 900S diesel engine viewed from the after end. A prototype of this engine has produced slightly more than 3000 hp per cylinder. Of the cross-head type, the engine operates on the two-stroke single-acting cycle.



High-Power Diesel Engine

THE February, 1960, "European Survey" carried a description of an experimental two-cylinder diesel engine of 900-mm bore and 1600-mm stroke, built by the FIAT Stabilimento Grandi Motori, of Turin, Italy, as the prototype of a nine-cylinder engine they had on order for a 38,000-ton tanker building at Castellamare. On test this engine had produced the remarkable output of 2650 hp per cylinder. The June, 1960, "Survey" reported some further tests in the course of which an output of slightly more than 3000 hp per cylinder was recorded. Though no engine of this new type (termed by the makers the 900S) is yet at sea, orders have been received for 10 large units, four to be built by FIAT at Turin and the others by licensees. The first of these, for the ship building at Castellamare, completed its shop trials in December and is now being installed on board the vessel.

The engine operates on the two-stroke single-acting cycle and is of the crosshead type, with cross-scavenging on the FIAT system, in which there are no scavenging valves and exhaust-turbine superchargers are used in conjunction with reciprocating air pumps. In this engine there are four turbochargers, set in line along the starboard side of the cylinders. All nine cylinder covers can be removed without disturbing any of the air ducting. During a 5-hr demonstration run in the FIAT works, following the shop trials, the engine was started at 8 a.m. It was warmed up for about $1^1/_2$ hr before starting an observed test of 1 hr at 124 rpm, corresponding to 22,000 bhp. With an mep of 8.73 kg/cm^2 (= 124.2 psi) the mean power developed was 22,022. This run ended at 10.35 a.m., after which the speed was stepped up to 127.5 rpm and, at 10.45 a.m., another 1-hr run begun. The engine averaged 127.9 rpm over the hour, giving 24,096 bhp at an mep of 9.25 kg/cm^2 (= 131.6 psi). Finally, the speed was increased to 131 rpm, and maintained at an average of 131.4 rpm for 30 min. Over this half hour the mep was 9.76 kg/cm^2 and the corresponding bhp was 26,096. The fuel oil used had a sp gr of 0.893 at 15 C (59 F). The mean exhaust tem-



The British Railway System's "Roadrailer" is a double-duty vehicle that runs as easily on the rails as on the road. For road use, **far left,** the rail car becomes a "trailer" coupled to a road tractor, its rail wheels retracted in favor of tires. Wheel mechanism, **left,** is operated by air from a portable compressor.

perature of the nine cylinders was 342.7 C (649 F), the highest and lowest figures being 347 C and 339 C, respectively. The engine ran throughout with a notable freedom from vibration.

Freight Vehicle for Road and Rail

It is not unknown for a bright idea to occur simultaneously to entirely independent inventors. The invention of the tilting-pad thrust bearing by Kingsbury in the United States and Michell in Australia is a notable example. Something similar seems to have happened in the case of the "Roadrailer," a vehicle designed to run with equal facility on railway track or on a road. It was devised simultaneously and independently by the Chesapeake & Ohio Railway and by British Railways, and developed along such closely parallel lines that the engineers of the two systems took the sensible course of uniting their efforts to produce the prototypes. In the British Isles, the main development contractors have been the Pressed Steel Company of Cowley, Oxford, England. A vehicle of their construction was demonstrated recently in London.

As a road vehicle, the Roadrailer differs from an ordinary truck in that it carries in its rear end a pair of railway wheels that can be raised clear of the ground. At the front end it is supported on the chassis of the tractor unit. When it is to be used on railway track, the railway wheels are lowered and the rear road wheels raised by means of a built-in 6-hp air motor, and the front end is carried on an adaptor bogie fitted with standard railway buffers and drawgear. On it is a rotatable superstructure, carrying the Roadrailer coupling socket and free to rotate through 360 deg, so that the bogie does not need to be turned. Small carrier wheels on jack legs take the weight of the car body while the adaptor bogie is brought into position. The jacks are of 16-ton capacity and are interconnected for manual operation.

The air motor, which raises and lowers the rear wheels, supplies air at 80 psi through connections at the side of the vehicle. A small portable compressor provides all the capacity needed. The motor is reversible and runs at 5500 rpm. British Railways, and the corresponding nationalized road organization, British Road Services, have carried out exhaustive tests with the Roadrailer, with satisfactory results. On road, it was tried out over the Motor Industry Research Association's test track at Nuneaton, England.

Fresh Water From the Sea

The Glasgow, Scotland, firm of G. & J. Weir, Ltd., has recently completed in Guernsey, Channel Islands, a sea-water distillation plant designed to produce 500,000 Imperial gal of fresh water daily to supplement the supply obtained from the island's reservoirs. Built for the States of Guernsey Water Board, it is the first of its kind to be erected in the temperate zone. Its capital cost of about $720,000, including the sea-water intake and pipelines, is reckoned to be rather less than one third of the cost of providing the equivalent additional storage. The operating cost is expected to be about 7 shillings per 1000 Imperial gal (about 81 cents per 1000 U.S. gal).

The installation comprises a boilerhouse containing two Spencer-Bonecourt "Steambloc" packaged boilers, each rated at 13,000 lb/hr at 245 psig; and a distillation plant, 69 ft long, 19 ft wide, and 15 ft high, internally divided into a number of flash and preheater chambers. In these flash chambers the atmospheric pressure is reduced by means of an air ejector, so that the hot sea water, entering a partial vacuum, flashes off salt-free vapor, which is condensed in heat exchangers as pure distilled water. The two boilers also supply steam to a compound engine that drives a 550-kw alternator. Power from this set operates the pumps serving the plant. A control room near the boilerhouse contains, in addition to the indicating and recording instruments, an audible and visual alarm that operates if the salt in the distillate rises to 100 parts per million. In this event, the distillate is automatically discharged to waste.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Substance in Brief of Papers Presented at ASME Meetings

ASME TECHNICAL DIGEST

Heat Transfer

Problems in Rating Severity of Exposures to Heat..60—WA-232...By H. S. Belding and T. F. Hatch, Mem. ASME, University of Pittsburgh, Pittsburgh, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The problem of rating the severity of exposures to heat, that is, of predicting the effects of exposure on the basis of knowledge of the environment and the activity and physiological characteristics of those subject to exposure, is discussed. It is believed that an adequate solution to the problem of grading heat stress in terms of probable acute strain for the young, fit, and acclimatized standard man is near at hand. This is because of the large body of physiological data on the standard man and the considerable improvement in ability to assign quantitative values to the elements of stress. When that task has been accomplished there will remain the need to develop a way of assessing fitness, or individual deviation from the physiological characteristics of the standard man, so that meaning can be assigned heat stress values on an individual basis.

A Comprehensive Approach to the Analysis of Cooling Tower Performance..60—WA-85...By Donald R. Baker, Mem. ASME, and Howard A. Shyrock, The Marley Company, Kansas City, Mo. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The difficulties encountered in predicting cooling-tower performance are directly related to the precision that is required. There is no general agreement on what constitutes acceptable accuracy.

The generally accepted concept of cooling-tower performance was developed by Merkel in 1925. His analysis combines the sensible and latent heat transfer into an over-all process based on enthalpy potential as the driving force. A number of assumptions and approximations were used to simplify the development of the final equation. Accuracy is sacrificed as a result, but modifications may be made in the application to minimize the resulting errors.

This paper deals with the errors in the mathematical analysis and describes the means of minimizing them. The development of the basic equation is reviewed in order to see how it is applied to both crossflow and counterflow towers, and to understand how the calculations may be modified to increase the accuracy.

Each improvement makes the analysis more difficult. No attempt has been made to evaluate this or to consider the effect of each source of error on the over-all accuracy.

The object is to describe methods that will give a satisfactory answer, without regard to the effort needed.

Oscillations in Two-Phase Flow Systems..60—WA-209...By G. B. Wallis, Atomic Energy Establishment, Dorchester, England; and J. H. Heasley, Dynatech Corporation, Cambridge, Mass. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1961).

In recent years the problem of oscillations in boiler tubes, natural-circulation loops, and two-phase flow chemical systems has become of great interest to engineers. Experiments have been performed and results are available in the literature, but there is still a shortage of adequate theoretical understanding of the phenomena.

Often, the onset of oscillations represents the limit of operating conditions for a given system. Several rules of thumb are available for precautions which should be taken in the design of such systems and for the kinds of modification to a given setup which will tend to cure the instability. What is needed is a logical theoretical basis for the prediction of system performance in advance and for systematic optimization of the various parameters.

This paper contains a mathematical analysis of three modes of oscillation of a simple two-phase flow, natural-circulation system, together with qualitative results of experiments with a small-scale loop model. The basic approach is to consider the loop as a dynamic system of nonlinear time delays, storage elements, and resistances. Standard methods of control-theory analysis can then be applied to predict instabilities.

Application of Peltier Refrigerators to Space Vehicles..60—WA-238...By Marshall E. Stelzriede, North American Aviation, Inc., Downey, Calif. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

There is an intimate relationship between the subsystems of a space vehicle. Each in some way affects, and is affected by, the operation of all the others. For this reason, optimization of the entire vehicle system requires some compromise in the design of each subsystem. This paper explores some of the problems involved in the effective integration of Peltier refrigerators into a space-vehicle system. The potential applications of these components are discussed in the light of the compromise that must be made in their design.

Man in Cold Environments..60—WA-240...By Steven M. Horvath, The Lankenau Hospital, Philadelphia, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The influence of cold upon the human organism depends upon the integrity of the thermal regulatory mechanisms. Although much has been learned about man's ability to tolerate either a marked lowering of his body temperature or an exposure to low environmental tem-

Solar chamber and equipment trailer, **above**, with flexible air input and return ducts, for studies of the thermal effects of solar radiation on human subjects. An air input duct runs along each side of chamber under wood floor. Mylar film stretched over metal frame forms "skin" of chamber. Subject, **left**, instrumented for measurement of physiological reactions, walks on treadmill in center of floor (60—WA-251).

peratures without such a depression, there still remains a great deal to be done before these adjustments can be sufficiently precisely prestated.

Man in a cold environment is discussed, considering temperature variations of the body, performance efficiency in cold environments, and hypothermia.

It is concluded that the simplification of these biological facts to prediction formulas remains for the future.

Studies on Thermal Effects of Solar Radiation in Transportable Solar Chamber.. 60—WA-251...By Douglas H. K. Lee and John A. Vaughan, Research and Engineering Command, Natick, Mass. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The climatic elements that determine the net rate of heat loss from the human body, and thus the ease with which it can achieve a heat balance, are four in number: temperature, humidity, air movement, and radiation. It is not easy to deal with a situation determined by four mathematically, although not casually, independent variables such as these. The practical expression of the physiological significance of the thermal factors in environment would be greatly simplified if the combined effects of all four could be expressed in terms of a single index. The paper describes experimental studies designed to develop the essential data with results obtained.

It describes a method of determining the increment of air temperature that would produce a physiological effect on man equivalent to that induced by the solar radiation load imposed under open summer conditions in mid-latitude deserts. The method consists of: (*a*) exposing subject to solar radiation in a transparent chamber with controlled temperature, humidity, and air movement; (*b*) exposing the same subjects to the same conditions with the solar radiation excluded, but at various temperatures above that used in the solar exposure; (*c*) establishing regression equations of physiological reactions on air temperature from the preceding step; (*d*) determining from these regression equations the air temperature which, acting alone, would have produced the same reaction as the solar exposure (ECAT); and (*e*) determining the increment of air temperature equivalent to the radiation load (ITER) by subtracting from ECAT the air temperature prevailing during the solar exposure (ACAT). A brief description is given of the solar chamber and the air-conditioning equipment, which is installed in two trailers for transportation.

Design of a Heat Rejection System for the SNAP 2 Space Nuclear Power System.. 60—WA-237...By R. Stone and M. Coombs, Atomics International, a Division of North American Aviation, Inc., Canoga Park, Calif. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The 3-kw SNAP 2 power system currently under development by Atomics International for the Missile Projects Branch of the Atomic Energy Commission, Aircraft Reactors Office, uses a mercury Rankine cycle to convert heat, generated in a nuclear reactor, to electrical energy. The Rankine cycle requires the rejection of heat by condensation of the working fluid, and, because of the space environment, the heat rejection must ultimately be accomplished by thermal radiation to space.

The SNAP 2 design employs a direct-condensing radiator. In this design, the heat released in the condensation process is radiated to space from a large extended surface which also serves as the vehicle skin. The tubes are attached longitudinally to the skin.

A method for minimizing system weight is presented in which the interactions between the problem areas of heat transfer, fluid flow, meteoroid environment, and zero-gravity operation are shown. Extension of the method to other systems is described.

Axial Temperature Distribution for a Nuclear Reactor With Sinusoidal Space and Exponential Time-Varying Power Generation..60—WA-194...By W. O. Doggett, North Carolina State College, Raleigh, N. C.; and E. L. Arnold, U. S. Military Academy, West Point, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer**; available to Oct. 1, 1961).

Analytic temperature distributions are obtained for the fuel and coolant regions of a heterogeneous, convection-cooled reactor with axial power variation $e^{\omega z} \sin(\pi z/H)$. The fundamental assumption in the governing differential equations is that the temperature distribution in the fuel region does not vary in the direction transverse to the coolant flow. The solutions involve two and three-parameter integrals encountered and numerically evaluated previously, which are integrated herein and arranged in a form suitable for desk calculations. Closed-form expressions are developed for the final steady-state axial distributions which are applicable at times long in comparison with the characteristic temperature-response times.

Shell Radiation..60—WA-234...By John W. Tatom, Assoc. Mem. ASME, Lockheed Aircraft Corporation, Marietta, Ga. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

An analysis is made of the steady-state temperature distribution along the surface of two simple, yet appropriate, hollow geometric bodies, located in interplanetary space, receiving energy from the sun, and radiating to infinity.

Differential equations describing the steady-state thermal behavior along the surface of a hollow sphere and an in-

finitely long hollow cylinder, both located in the solar radiation field, are solved. The equations, written for generality in nondimensional form, include the effects of conduction, internal radiation, natural radiation, and solar radiation. Typical solutions to these equations are presented here in graphical form. Among other things, the results demonstrate the strong effect of the interior to the exterior emissivities on surface temperature variation.

Steady-State Temperature Distribution in a Counterflow Heat Exchanger Including Longitudinal Conduction in the Wall..60—WA-236...By H. G. Landau and J. W. Hlinka, Heat and Mass Flow Analyzer Laboratory, Columbia University, New York, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

In studying the temperature response of straight flue regenerators, it is found that the results can be approximated by those for a counterflow heat exchanger if the reversal period is short. Furthermore, computations on the heat and mass flow analyzer show that for some cases the conduction in the wall, longitudinally, is not negligible and can affect a decrease in efficiency.

The general steady-state temperature distribution is given for a counterflow heat exchanger including conduction along the wall. Since this general solution is expressed by rather complicated formulas, simple approximations are given which are useful in many practical cases. Also, in order to decide whether conduction along the wall is significant, a simple method of estimating the effect is included.

An Investigation of Porous Wall Cooling..60—WA-233...By Richard P. Bernicker, Naval Supersonic Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The aerodynamic heating of a body as it moves through the atmosphere at supersonic and hypersonic velocities has introduced major problems into the design of both manned aircraft and missiles. The heating rate, at high enough Mach numbers, becomes so extreme as to prohibit sustained flight.

It may be possible to dissipate the heating load by absorbing it in some sort of coolant, followed by ejection of the coolant from the vehicle into the airstream.

Equations are developed to describe the thermal exchange when a coolant is forced through a heated porous wall, and solutions are obtained on the basis of a simplified model consisting of identical cylindrical channels replacing the actual capillary-like passages. The solutions depend upon Reynolds and Prandtl numbers, geometric parameters involving wall porosity and pore size, and Nusselt number. Experiments were performed with one family of porous materials, and Nusselt numbers were correlated in terms of Reynolds and Prandtl numbers, and porosity. Nusselt number varies almost linearly with Peclet number. Temperature distributions indicate a very small difference between solid and coolant temperatures at the exit surface.

The Effect of a Longitudinal Magnetic Field on Pipe Flow of Mercury..60—WA-192...By Samuel Globe, Harvard University, and Research and Development Division, AVCO Corporation, Wilmington Mass. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1961).

When an electrically conducting fluid flowing through a pipe is subjected to a magnetic field parallel to the direction of the flow, there will be no interaction between the fluid and the magnetic field as long as the flow is laminar because the flow and the magnetic vectors are then parallel. If the flow is turbulent, however, there will be components of velocity perpendicular to the magnetic field, and an interaction can be expected. The interaction will result in generated emf and currents in the field. These currents will in turn interact with the magnetic field to produce a ponderomotive force. By Lenz's law, the direction of this ponderomotive force will be such as to oppose the transverse motion that gave rise to the interaction.

Thus it is speculated that a magnetic field parallel to the direction of flow in a pipe may represent an additional stabilizing influence, and may thereby delay the transition from laminar to turbulent flow.

An experimental investigation was made of the effect of an axial magnetic field on transition from laminar to turbulent flow and on the turbulent friction factor for pipe flow of mercury. Magnetic-flux densities up to 5700 gauss were obtained with a water-cooled solenoid. Pipes of glass and aluminum were used for approximately 0.1 to 0.2 in. diam. The maximum Hartmann number, with the hydraulic radius (half the actual radius) taken as the characteristic length, was about 20. Measurements were made of the pressure gradient and velocity of flow. The transition Reynolds number was determined from the curve of friction factor against Reynolds number. The results show an increasing value of minimum transition Reynolds number with Hartmann number. The magnetic field also brought about a decrease in the turbulent friction factor and corresponding shear force at the wall.

Unsteady Laminar Flow in a Duct With Unsteady Heat Addition..60—WA-174... By Morris Perlmutter and Robert Siegel, Assoc. Mem. ASME, Lewis Research Center, NASA, Cleveland, Ohio. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1961).

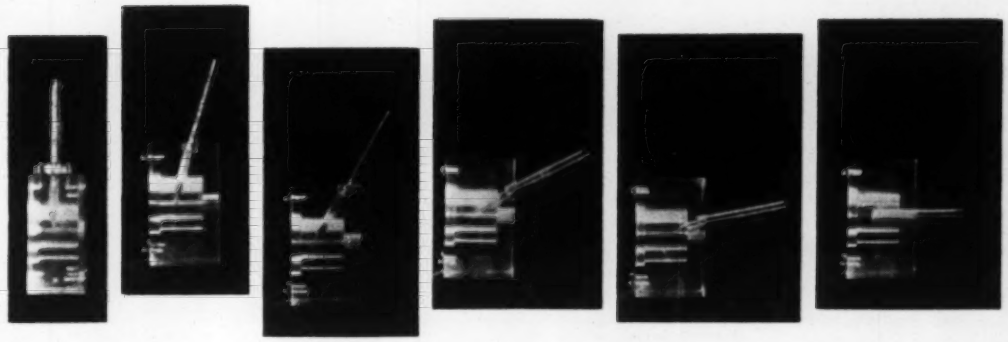
An analysis is made of transient heat transfer with transient laminar flow between heated (or cooled) parallel plates. The transient processes are caused by simultaneously changing the fluid pumping pressure and either the wall temperature or the wall heat flux. The solution is obtained for both the thermal entrance and fully developed heat-transfer regions. The slug-flow simplification is made; that is, the velocity at any instant of time is taken as uniform throughout the channel. The fluid temperature distribution, however, depends on both the axial co-ordinate and the position within the channel cross section. A few numerical examples are carried out which give some insight into various transient processes such as those occurring during a nuclear-reactor shutdown.

Temperature Distribution in a Slab Moving From a Chamber at One Temperature to a Chamber at Another Temperature..60—WA-197...By G. Horvay, Mem. ASME, General Electric Research Laboratory, General Electric Company, Schenectady, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1961).

When an infinitely long slab travels from a chamber at one temperature to a chamber, isolated from the first, at a higher temperature, heat will leak out along the slab from the second chamber to the first, whose amount decreases as the speed of the slab increases. An estimate of the heat lost is of interest in hot-rolling, in some nuclear processes, and in some continuous casting processes. The problem of determining the temperature distribution and the heat flow in the two chambers is formulated in the form of dual integral equations, and the solution is obtained by the method of Wiener-Hopf.

Unsteady Laminar Free Convection..60—WA-211...By P. M. Chung and A. D. Anderson, Assoc. Mem. ASME, Ames Research Center, NASA, Moffett Field, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1961).

The unsteady, laminar, free-convection boundary layer is analyzed with the Grashof number considered to be time-dependent through either the uniform wall temperature or the acceleration field.



These six entry blocks were designed to study the influence of the entry angle on performance of the vortex tube. Entry angles of 90, 70, 60, 45, 30, and 15 deg were used (60—WA-239).

Two geometries are considered: the vertical plate and the horizontal circular cylinder. A set of parameters is derived through which it is possible to describe the unsteady behavior of the boundary layer. These parameters allow solutions of the pertinent differential equations to be expressed in series form, and an infinite number of sets of perturbation equations result. Numerical integrations of the first few sets are shown graphically. These results enable one to visualize and to calculate the time-dependent deviations from the quasi-steady velocity and temperature profiles as well as the deviation in heat transfer.

Effect of Hydrogen Recombination on Turbulent Flow Heat Transfer..60—WA-256...By W. H. Giedt, Mem. ASME, University of California, Berkeley, Calif.; L. L. Cobb, Jr., Sandia Corporation, Livermore, Calif.; and E. J. Russ, General Dynamics Corporation, San Diego, Calif. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

An investigation of the heat transfer from an oxyacetylene flame having approximately 10 per cent atomic hydrogen by volume is described. The heating apparatus employed was designed to provide heat transfer from a turbulent gas stream flowing parallel to a flat-plate specimen. Heat transfer for such a system when some of the gas is dissociated was analyzed by including an energy source term in the boundary-layer energy equation. Both catalytic surface recombination and volume recombination within the boundary layer were considered as possible mechanisms. Experimental measurements were therefore made of heating rates to two surfaces having widely different catalytic efficiencies.

Results showed that the effect of hydrogen recombination is to increase the heat transfer from an oxyacetylene flame from 30 to 90 per cent over that predicted with no recombination, and that this effect is due to near equilibrium recombination in the boundary layer. Heating rates can be predicted by correcting the nondissociative heat-transfer coefficient by a factor involving the free-stream hydrogen-atom concentration and the recombination energy release.

A Study of the Influence of Entry Angle in Vortex-Flow Temperature Separation..60—WA-239...By J. E. Lay, Assoc. Mem. ASME, and B. C. Lee, Michigan State University, East Lansing, Mich. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The influence of the entry angle in vortex-flow temperature separation, based on experimental studies conducted for the Office of Ordnance Research, United States Army, is reported. The performance characteristics of a vortex tube with respect to a wide range of "entrance" angles, from 90 deg (tangential flow) to 15 deg (near axial flow), are given. Heretofore, data of this nature have been entirely lacking in the literature of the Ranque-Hilsch effect. The experimental program was conducted on both the uniflow and the counterflow types of vortex tube, with pressure, temperature, and velocity traverses taken at different stations along the length of the tube.

Radiation Interchange in a Nongray Enclosure Containing an Isothermal Carbon-Dioxide-Nitrogen Gas Mixture..60—WA-210...By D. K. Edwards, Assoc. Mem. ASME, University of California, Los Angeles, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1961).

Radiation involving carbon-dioxide gas is a significant mode of heat transfer in such enclosures as industrial furnaces and rocket combustion chambers. Formerly, calculations of such heat transfer have been possible only for the case of an isothermal gas in a gray enclosure. Recent measurements have made possible the analysis of heat transfer to nongray walls.

Data and computational methods used in calculating radiant interchange through isothermal carbon-dioxide-nitrogen mixtures are reviewed. The utility of band-absorption correlations is illustrated by the development of criteria for selection of band limits and geometric absorption factors for the simple infinite parallel plane enclosure.

Safety

Stimulating New Safe Industrial Uses of Radioisotopes..60—WA-181...By Robert E. Black, General Motors Research Laboratories, Warren, Mich. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

A joint training program conducted by General Motors Institute and the Research Isotope Laboratory was begun in May, 1957. The last class was graduated in March, 1960. The over-all picture of the results of the training program is quite favorable. Two new radioisotope laboratories have been started as a result of it, and three more are being planned. About 70 per cent of the graduates have used their training in one or more feasibility studies, projects, or installations. More than two dozen projects are currently being pursued by the Isotope Laboratory with various General Motors Divisions as a direct result of the training courses.

The manner in which considerations of radiological safety were integrated into the program is noted. The success of the program in meeting its objectives is evaluated, and examples are given of projects which have been initiated by graduates. These projects involved (*a*) a nuclear sand-moisture gage in which a radioisotope is used in a production tool; (*b*) a project for measuring the wall thickness of hollow turbine blades and vanes; and (*c*) an investigation of the rates of diffusion of lead, sulfur, the halogens, and their compounds in various ceramic materials.

In conclusion, it was recognized that the lack of trained men was the key factor in preventing radioisotopes from being used to the greatest advantage in industry.

Mental Functions and Safety..60—WA-189...By E. V. Crane, Mem. ASME, E. W. Bliss Company, Canton, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Safety problems of physical hazards correlate directly with mental hazards. Both are clarified by noting three major mental bodies and their functions from

safety and engineering points of view. Thus stray electrical signals from (inattentive) conscious center activity may disrupt both physical and mental practiced routines proceeding under subconscious (cortical) direction, with resultant accident or error. Voluntary manipulation (only) of learned wisdom is also potentially unsafe to the individual without motivating and evaluating services of the other, the inadequately known (autonomic) neural system. Educationally communicable mental disease (cortical malconditioning) constitutes a further and increasing mental hazard in engineering and executive ranks.

It is concluded that an engineering familiarity with the mental bodies, and their functions and disciplined maintenance, is essential in promoting safety.

Engineering in Resuscitation..60—WA-196...By Benjamin Smilg, Globe Industries, Inc., Dayton, Ohio. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

The processes of respiration are analyzed from an engineering point of view and the requirements for resuscitator design are outlined. A review of pertinent engineering considerations is presented. Several commercially successful resuscitators are described to show their principles of operation. Included is a discussion of nonautomatic resuscitators, automatic resuscitators, and valves.

Information and Education for Industrial Use of Radioisotopes..60—WA-206...By Paul J. Blaetus, Office of Isotopes Development, U. S. Atomic Energy Commission, Washington, D. C. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The author reviews briefly the significant publications and services now available to those interested in the literature of nuclear energy and the use of radioisotopes in research and application. An outline is given of the educational and training resources for the use of radiation techniques. The Atomic Energy Commission's Isotope Technology Program, designed to insure the availability of trained personnel for full exploitation of this field, is described.

Industrial Applications of Radioisotopes ..60—WA-207...By Paul C. Aebersold, Office of Isotopes Development, U. S. Atomic Energy Commission, Washington, D. C. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

A résumé is given of the many industrial applications of radioisotopes "the foremost peaceful, civilian application of atomic energy." It indicates that even greater utilization of radioisotopes by industry has been delayed owing to the limited number of properly trained isotope scientists, engineers, and technicians, and the undeveloped necessary technology and unfamiliarity with the new tool. Stress is placed on the fact that "radioisotopes are one of the safest tools one can envision in industrial use."

Advantages of the many uses of radioisotopes are detailed and note is made that the AEC is supporting research leading to increased uses through schools, universities, and the office of Isotopes Development. It is pointed out that present uses are only a small part of an "enormous potential" for the industrial uses of radioisotopes.

Applied Mechanics

Heat Transfer and Sublimation at a Stagnation Point in Potential Flow..60—WA-20...By W. W. Short, Convair Division of General Dynamics Corporation, San Diego, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1961).

A simple analytical expression is derived which predicts the effect of mass transfer on countercurrent heat transfer to a vaporizing body. This phenomenon is of current interest as it usually occurs during an ablation process.

In this theory, the fluid stream is assumed to be inviscid and of constant thermal conductivity. The inviscid theory correlates well with heat-transfer data without mass transfer and is believed to predict heat-transfer rates fairly accurately at high mass-transfer rates.

Information Theory as the Basis for Thermostatics and Thermodynamics..60—WA-23...By Myron Tribus, Mem. ASME, University of California, Los Angeles, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1961).

Information theory described in Part 1 of this paper provides a meaning for the concept of entropy independent of the field of thermodynamics. Using this meaning (uncertainty) it is possible to derive all of statistical and classical thermodynamics in a direct and simple way. Many of the concepts and definitions of classical thermodynamics are given a new interpretation.

Using information theory as a basis for a statistical description of an open system, in Part 2, the laws and theorems of thermodynamics are seen to follow in a simple way. The coupling of irreversible flows (Onsager's relation) is seen as a natural connection between thermostatics and thermodynamics if the functions introduced by Massieu are used instead of those by Gibbs.

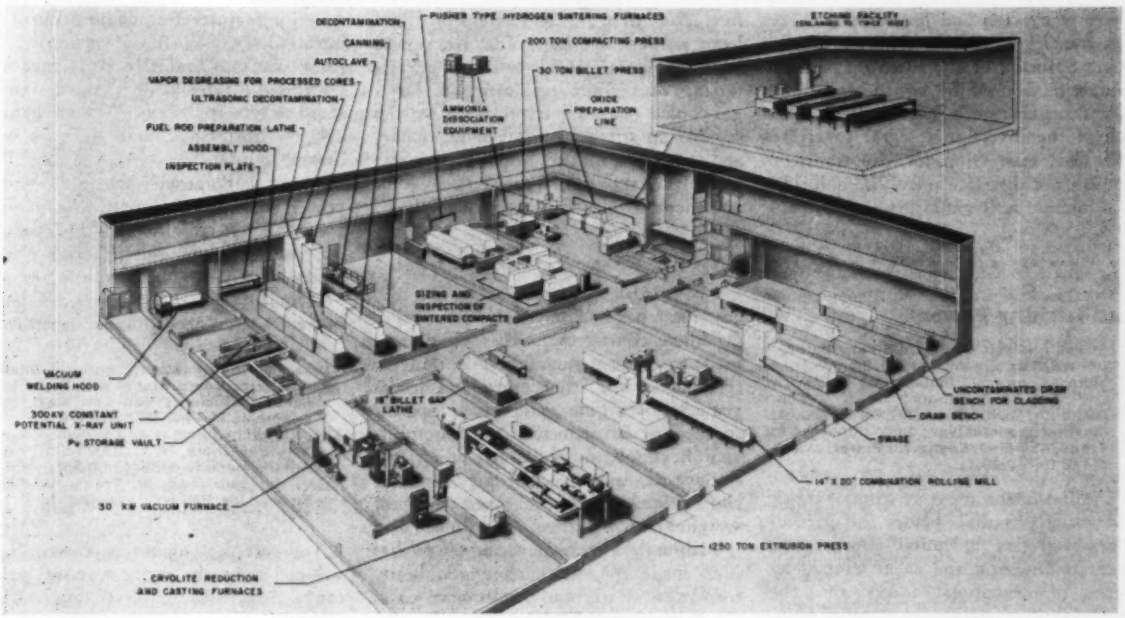
Transient Heat Conduction in a Rod of Finite Length With Variable Thermal Properties..60—WA-25...By W. H. Chu and H. N. Abramson, Mem. ASME, Southwest Research Institute, San Antonio, Texas. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1961).

Previous methods of determining the temperature-dependent diffusivity of materials are based almost entirely on analytical solutions for constant thermophysical properties, from which relations for the evaluation of thermal diffusivity can be deduced. However, in order to evaluate the thermophysical properties of materials from measurements of idealized one-dimensional transient heat flow (conduction) with large temperature variation, it is more desirable to have available sufficiently accurate solutions based on temperature-dependent thermal properties. Unfortunately, when the thermal properties are considered to be variable, the mathematical analysis leads to a difficult nonlinear integral equation.

A theoretical solution is presented for transient heat conduction in a rod of finite length with variable thermal properties. A numerical procedure is developed and the results of one example are presented and compared with the corresponding solution for the case of constant properties. Application to the problem of determination of thermophysical properties is discussed briefly.

Stress Distribution in a Rotating Spherical Shell of Arbitrary Thickness..60—WA-19...By M. A. Goldberg and V. L. Salerno, Mem. ASME, Grumman Aircraft Engineering Corporation, Bethpage, L. I., N. Y.; and M. A. Sadowsky, Mem. ASME, Watervliet Arsenal, Watervliet, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1961).

An exact solution is given for the stress distribution in an elastic spherical shell rotating about a diametral axis. The surfaces of the shell are free of boundary tractions. The coefficients necessary to determine the stresses at any point have been calculated for eight values of a thickness parameter, α. Graphs of the maximum stress intensity as a function of α are presented.



First-floor process area of two-story Plutonium fabrication plant, Hanford Works. Area holds large fabrication equipment (60—WA-225).

Nuclear Engineering

The Design and Status of the Reactor and Pilot Plant for the Plutonium Recycle Program..60—WA-225... By R. M. Fryar, Assoc. Mem. ASME, General Electric Company, Hanford Atomic Products Operation, Richland, Wash. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The Plutonium Recycle Program, which was initiated in mid-1956, has as its objective the acquisition of the technology necessary for the practical utilization of plutonium as a fuel in thermal heterogeneous power reactors. Early in the program it became apparent that two new major facilities would be required to accomplish the objectives of the program expeditiously: (*a*) A facility would be acquired where plutonium and plutonium compounds could be fabricated into fuel elements on a pilot-plant scale; (*b*) a reactor would be required to furnish scientific and engineering data on irradiation behavior. The pilot plant was activated in August, 1959, and in February, 1960, the first plutonium elements were fabricated. The plutonium recycle test reactor was nearing completion in June, 1960.

Details of the program and its progress are given in the paper. Included are brief outlines of the fabrication of plutonium-oxide-bearing fuel elements and the design of the plutonium recycle test reactor.

A Binary-Vapor Nuclear-Power Plant..60—WA-309... By David R. Sawle and J. Kenneth Salisbury, Fellow ASME, Aerojet-General Nucleonics, San Ramon, Calif. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Higher economic efficiency in a nuclear power plant, as in any power plant, results from the reduction of fuel cost per unit of energy output, or the reduction of fixed charges, or both. Reduction in fuel cost may be accomplished by an increase in the thermal efficiency, that is, the energy output obtained from a given amount of fuel. Since the reactor represents a large fraction of the capital cost, more electrical output per thermal megawatt of reactor rating simultaneously reduces the fixed charges on the reactor. Thus higher thermal efficiency has a far-reaching and in fact a dual effect in reducing power cost in a nuclear plant.

It is possible under the binary sulfur/steam system described in this paper to achieve a very high thermal efficiency in the power loop, thus reducing fuel cost and some of the fixed charges.

Steady-State Fluid Flow in a Closed Loop With Two Parallel Channels..60—WA-287... By Thomas R. Bump, Mem. ASME, Argonne National Laboratory, Argonne, Ill. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

In general, it is necessary to use trial-and-error methods to calculate coolant flow rates in nuclear reactors that are cooled by natural, thermally induced circulation, and that provide parallel channels for the coolant flow. However, an exact solution for this problem is obtainable if it is assumed that (*a*) only two parallel channels are involved, (*b*) imposed pressure differentials are independent of coolant flow rates, and (*c*) head-loss coefficients are independent of coolant flow rates.

While this solution obviously does not apply to many actual situations, it does help to clarify the general characteristics of the systems involved, and provides a straightforward approach to the trial-and-error solution of more realistic problems. The exact solution is applicable to any system that includes parallel flow channels, each free to exchange energy independently with its surroundings. Methods for lumping several parallel channels into one are available.

Transient Thermal Stress in Tubular Reactor Elements..60—WA-248... By La Mar I. Deverall, University of California, Lawrence Radiation Laboratory, Livermore, Calif. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

A theoretical solution is developed for the transient thermal-stress distribution in a reactor fuel tube of circular cross section with spatially uniform internal-

power generation and forced convective heat transfer at the inner surface of the tube. Solution of the equation of heat conduction is done by means of the Laplace transform with subsequent application of the inversion integral to arrive at a final expression for the transient temperature distribution. The solution is of interest in the analysis of transients in reactors that use either a gas or liquid heat-transfer medium. The work was initiated in conjunction with the quench testing of ceramic fuel elements for a gas-cooled reactor. Expressions for the component stresses are given explicitly, and examples of application of these formulas to startup of a gas-cooled reactor and the flow quenching of a fuel tube.

Gas Turbine Power

Stress Analysis of a Radial-Flow Rotor..60—WA-200...By M. J. Schilhansl, Ford Motor Company, Engineering Research and Advanced Product Study Office, Dearborn, Mich. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

A radial-flow rotor consisting of a disk and exactly radial blades experiences normal stresses in radial and circumferential direction and shear stresses by virtue of centrifugal forces and the torque, respectively. The paper's investigation is restricted to the analysis of the effect of the centrifugal forces, primarily because this is the predominant effect at high speeds at least so long as the rotor is not subjected to torsional vibrations. Special attention is paid to the mutual interference of disk and blades.

Turbocompressor Drive Couplings..60—WA-212...By J. H. Anderson, Mem. ASME, Borg-Warner Corporation, York, Pa. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

The requirements for high-speed centrifugal compressor drive couplings and some of the problems created by conventional couplings are discussed. Two new coupling designs and their advantages in meeting compressor drive requirements are described.

The first of these designs was a twin disk and spacer type coupling which, although an improvement over previous couplings, did not fully satisfy basic requirements. Consideration of its various defects led to the development of a new type coupling that worked on the same principle but was designed to get around the difficulties encountered. It is described, and its advantages over the previous design are listed.

A Study on Design Criteria and Matching of Turbomachines: Part A—Similarity Relations and Design Criteria of Turbines ..60—WA-230...By O. E. Baljé, Mem. ASME, Hollywood, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

Only four parameters are needed to describe the characteristics of turbomachines completely. This concept is used to present maximum obtainable efficiencies and the optimum design geometry of turbines as function of specific speed, specific diameter, Mach number, and Reynolds number, based on the state-of-the-art knowledge. Additionally, other aspects such as unit weight and rotor stresses are discussed.

Although a conscientious effort has been made to collect all available information on turbine-performance data, some of the N_sD_s-diagrams presented are necessarily of preliminary nature, and are labeled as such, due to the still incomplete knowledge of the interrelation between losses and geometry. This emphasizes the need for additional research in the field of turbomachines.

A Review of Supersonic Compressor Development..60—WA-294...By J. F. Klapproth, General Electric Company, Cincinnati, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

Since all of the known published work on supersonic compressors is now available, the original intent of this paper was to collect and summarize the results attained. But in exploring the subject from this point of view, it became apparent that relatively little further value would be anticipated. There did appear to be a need, however, to evaluate the past work on supersonic compressors in the light of the more than fifteen years' experience accumulated in this and closely related fields. Since the NACA work was the most extensive continuous development effort of the supersonic compressor and it is relatively completely reported, it is the primary basis of the discussion to follow.

The NACA supersonic-compressor investigations were initiated at the Langley Research Laboratory. A closed-loop test facility was developed and the early compressor testing was conducted using Freon 12. (The Freon testing significantly reduced power requirements and permitted simplified rotor-fabrication techniques.) Following relatively encouraging results after modification of the initial design, the final version of the rotor was mechanically redesigned and fabricated for operation at the design tip speed of 1600 fps in air. The mechanical design, fabrication, and air tests were carried out at the NACA Lewis Propulsion Laboratory where adequate power and an air-supply system were available. After about 1947, a parallel effort was carried out at both NACA laboratories.

Included are discussions of design procedures and operational experience.

Some Investigations Into Transonic Axial-Flow Compressors With High Stage-Load Coefficients and Low Degrees of Reaction..60—WA-310...By Karl E. Wichert, Fairchild Engine and Airplane Corporation, Bay Shore, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

The turbojet engines as currently developed cover the entire practical power range required for civil application. Therefore the reduction of these engines in their size and weight must become a primary objective. With this reduction, increase in payload ability will be realized.

This paper describes an approach made by the Société Nationale d'Etudes et de Construction des Moteurs d'Aviation (SNECMA) to the development of transonic compressors for gas-turbine engines. In these compressors the number of stages required for a given outlet pressure can be greatly reduced. An engine retrofitted with such a compressor can be 30 per cent shorter and lighter.

A design for transonic axial-flow compressor is described, in which a rotor wheel with a low degree of reaction operates in subsonic flow and the stator operates in supersonic flow. A compressor was run as a single-stage compressor and an outlet pressure ratio equal to that of an orthodox compressor with four stages. Some discussion of another compressor in which both the rotor wheel and the stator operate in supersonic flow is also given.

It is considered that more work on this concept would provide further information that could be applied to the design of transonic axial-flow compressors much shorter and lighter than those of orthodox design.

Critical High Lights in the Development of the Transonic Compressor..60—WA-290 ...By R. O. Bullock, AiResearch Manufacturing Company, The Garrett Corporation, Phoenix, Ariz. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

Ever since the National Aeronautics

and Space Administration first demonstrated an efficient transonic compressor that realized the potential of high flow and high pressure ratio, there has been intense activity to capitalize on this discovery. Private industry and research organizations, including NASA, have devoted a large amount of effort toward widening this field.

The principal function of this paper is to summarize the important information acquired from single-stage transonic compressor research at NASA. This source of work was selected because it is the only declassified, published, and coherent information readily available at this time. The paper's secondary function is to appraise the current state of the art and indicate the outstanding problems and possibilities of transonic compressors.

The paper reviews the critical phases in the development and understanding of transonic compressors. The Mach-number problem in conventional subsonic compressors is first discussed. Information and ideas suggesting ways and means of overcoming these problems are presented and the incorporation of these ideas into the first successful transonic compressor reviewed. The program selected by NASA to pursue this development efficiently is then examined, and the results of the program discussed. The current views about the important similarities and differences between subsonic and transonic-compressor design are then indicated.

The problems of realizing available performance in practical designs are considered along with some possible effects of design errors and flow aberrations.

The Rotating Nozzle (Hero's) Turbine.. 60—WA-293... By John F. Brady, Assoc. Mem. ASME, U. S. Naval Underwater Ordnance Station, Newport, R. I. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

For a special underwater missile drive, a 200-hp rotating nozzle (Hero's) turbine was designed, fabricated, and tested.

Theoretical analysis indicates that, where high ratios of wheel to jet speed are possible, a rotating-nozzle turbine is worthy of consideration. Test data taken at low values of speed ratio confirm the validity of the analysis. Furthermore, for low-power turbines, a partial-emission rotating nozzle may provide a design having better performance than a conventional partial-admission impulse turbine. In missile auxiliary power plants, for example, turbine efficiencies between 20 and 40 per cent are common. The 20 per cent efficiency obtained at the low value of W/V_0 of 0.14 with the simple rotating nozzle makes it attractive for some short-duration missions.

This paper is the first of a series under preparation which will discuss the design and performance of various types of small turbines applicable to auxiliary power or underwater-missile main propulsive power.

Solar Energy

Solar-Energy Steam Generator: Parabolic-Cylinder Mirror Type..60—WA-89... by A. Ralph Yappel, Mem. ASME, University of Arizona, Tucson, Ariz. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

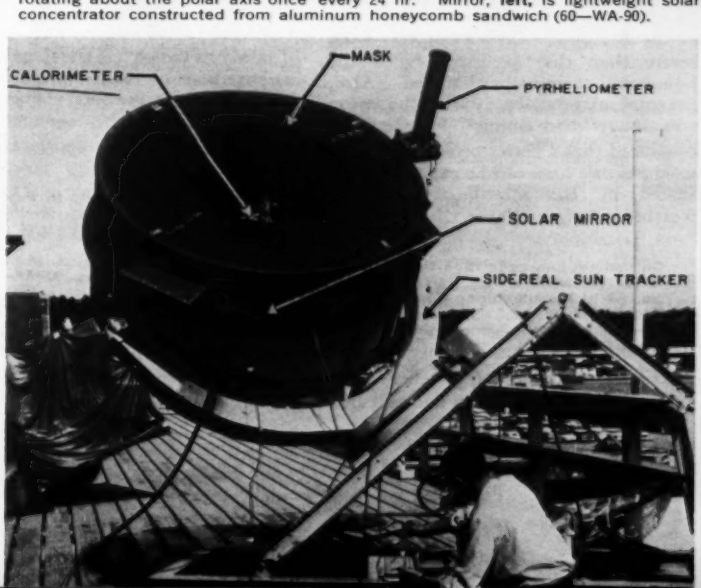
Dr. Charles G. Abbot, former secretary of the Smithsonian Institute, had his most recently designed solar steam generator erected on the University of Arizona campus in 1957. Unfortunately, owing to difficulties encountered, some physical changes in design had to be made. The material presented herein represents an analysis of the steam generator when in its final physical form.

After a brief discussion of the equipment, an analysis of performance data at different saturation temperatures is presented. A theoretical study of predicted performance is made for use of an improved focus tube. Abbot's original steam generator is briefly described. Owing to high cost of power production, this type of power plant may be useful on the earth's surface only in remote regions. However, this type of power generator may be utilized on space vehicles to advantage.

Lightweight Solar Concentrator Development..60—WA-90... By Roger Gillette, Howard E. Snyder, and Thomas Timar, Boeing Airplane Company, Seattle, Wash. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Lightweight, accurate solar concentrators are necessary components of some systems for using the solar heat available in space. Although efficient heat-to-electricity converters are also required, the scope of this paper is limited to the solar concentrator. Supporting structure and orientation devices are not discussed.

Theoretical studies point out the importance of optical surface finish and of concentrator accuracy. Practical requirements pose definite questions such as: How much heat can actually be concentrated on a small focal area? How heavy does a mirror have to be to perform properly after being shipped by truck, manhandled, and blasted off by rockets? To answer these questions, a program was initiated to make replica



Calorimeter test setup for evaluating the performance of solar concentrators, **below.** Mirror to be tested is installed in equatorial mount and made to track the sun by rotating about the polar axis once every 24 hr. Mirror, **left,** is lightweight solar concentrator constructed from aluminum honeycomb sandwich (60—WA-90).

mirrors and to determine their performance by tests. The results obtained in the first six months of the program are reported in this paper.

The objective of the research program was to develop a lightweight solar concentrator that would provide sufficient solar energy for space-vehicle power-conversion equipment. Solutions to processing problems such as tooling and parting of the lightweight replica mirror are discussed. Solar test data are furnished for performance evaluation. It was found that a 36-in-diam mirror weighing 2.9 lb (0.410 lb/sq ft) has the capability of providing sufficient energy for a 15-watt thermionic generator.

Progress in Space Heating With Solar Energy..60—WA-88... By C. D. Engebretson and N. G. Ashar, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

An M.I.T. Solar House IV was designed and built to extract part of its space heating and hot-water load from the sun. The house operated successfully during the winter of 1959–1960. The total solar incidence on the collecting area during the season was 122.4 million Btu, of which 32.4 million Btu was of too low intensity to justify attempted collection. The solar collector operated with an average efficiency of 45 per cent on the residue of 90 million Btu, extracting 40.9 million Btu on the surface of 640 sq ft at 60 deg tilt. The economic operating conditions can be estimated by maximizing the ratio of useful solar-energy collection to the total power cost of collection and heat distribution. For the present design, 110 deg F was found to be the economic optimum storage-tank temperature during the winter months.

A 46 per cent sharing of the total heat load by the solar system was realized. The solar-heated tank supplied 34.4 million Btu of the total heating load of 74.5 million Btu. However, the winter at the site of the experiment was more severe than that predicted when the house was originally designed. Also, the total solar incidence during the season was lower than normal. Hence it is concluded that a better percentage of the total heating load can be expected to be shared by the solar-heated tank if weather is more favorable.

On Radiant Energy in High-Temperature Research..60—WA-170... By Tibor S. Saszlo, AVCO Manufacturing Company, Wilmington, Mass. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Radiant energy is an excellent heat source for experimentation and measurements at high temperatures, and image furnaces are suitable tools for such work. For successful experimentation, however, it is important to take into consideration the special operating conditions of image furnaces. In most cases, conventional instruments and techniques cannot be used because of the small size and uneven flux distribution at the hot zone. A completely fresh approach must be taken for each type of experimentation when using high-intensity radiant energy. The size, shape, and mounting of the specimen may require unconventional arrangements. New methods of observation and measurements are discussed, together with instruments of special design. Because of the novelty of image furnaces, very little of this has been done up until the present time. It is concluded that with progress in this field a unique and versatile tool will soon be available for high-temperature research.

Limitations of the image furnace—the small size of the hot zone, the heating of only one side of the sample, and flux nonuniformity across the image area—are discussed. A new experimental technique is developed that makes it possible to obtain meaningful values of a property for narrow temperature intervals from measurements in the wide-range temperature distribution of an image furnace, if the distribution is well defined as in the solar furnace.

Lubrication

Theory of Lubrication and Failure of Rolling Contacts..60—WA-286... By B. Sternlicht, P. Lewis, and P. Flynn, Assoc. Mems. ASME, General Engineering Laboratory, General Electric Company, Schenectady, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

The fatigue life of rolling-element bearings has been the subject of numerous investigations. Most recently the influence of the lubricant on fatigue failure has been given added emphasis. This paper presents the results of an investigation that was undertaken to gain a better understanding of fluid behavior in the contact zone and to determine the influence of the lubricant on rolling-contact fatigue life.

The investigation had three distinct facets: (*a*) An analysis was performed on pressure and temperature distribution within the contact zone of rolling disks. (*b*) Dynamic stresses in two contacting cylindrical bodies were measured by means of photoelastic techniques. (*c*) High-speed ball-bearing fatigue tests were conducted with two specially blended oils which had the same viscosity at the bearing-inlet temperature, but widely different pressure viscosity characteristics. The paper summarizes the work and presents a hypothesis.

Air-Hammer Instability in Pressurized-Journal Gas Bearings..60—WA-10... By Lazar Licht, The Franklin Institute Laboratories, Philadelphia, Pa. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

A stability analysis is developed for gas journal bearings having externally pressurized pads, symmetrically spaced along the circumference. Simplifying assumptions are made and equations of flow and motion are stated in terms of perturbation quantities. The case considered is when the journal, initially in an eccentric equilibrium position, begins to move in an arbitrary direction under the influences of a small, random disturbance. Methods of factorizing and simplifying the characteristic determinants are shown, with the objective of reducing the work of examining the roots of characteristic equations. Special cases, such as the bidirectional thrust bearing and that of the journal initially in concentric position, are discussed. Numerical and semiexperimental procedures of determining the coefficients of characteristic equations are outlined. Stability tests are suggested. Bearing parameters affecting stability are discussed.

Inertia Effects in Hydrostatic Thrust Bearings..60—WA-315... By D. Dowson, Assoc. Mem. ASME, The University of Leeds, Leeds, England. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

The predominant inertia terms are included in an analysis of hydrostatic thrust bearings. The influence of centripetal accelerations on the distribution of pressure is found to be considerable. For parallel-surface bearings of constant film thickness the inertia effects are found to be detrimental to load capacity. In a stepped bearing, however, correct location of the step can result in an increased load capacity at speed. No increase in load capacity can result from inertia effects if the step radius is less than 0.4508 of the bearing radius. A consequence of the inclusion of inertia terms in the analysis is the existence of a velocity component in the axial direction.

Rubber and Plastics

An Introduction to Biaxial-Stress Problems in Fabric Structures..60—RP-8... By A. D. Topping, Goodyear Aircraft Corporation, Akron, Ohio. 1960 ASME Rubber and Plastics Conference paper (multilithographed; available to Aug. 1, 1961).

Reasons for the increasing interest in fabrics as structural materials are discussed, and the superiority of fabric to isotropic sheet and films in tear resistance is given an analytical basis. The shearing stiffness of single-ply fabrics is investigated and found to be a function of the stress level and of the boundary conditions. Two important special cases are analyzed, both of which yield the result that the stiffness is equal to the stress in one set of threads. Experimental data from inflated cylinders of neoprene-coated nylon (*a*) with threads at 45 deg with the cylinder axis, loaded by axial tension, and (*b*) with threads circumferential and axial, tested in torsion, support the theory. It can be extended to apply to shearing deflections of airmat beams.

A New Viscoelastic Compound for the Suppression of Noise and Vibration in Structures..60—RP-10... By Charles H. Peterson, Hughson Chemical Company, Division of Lord Manufacturing Company, Erie, Pa. 1960 ASME Rubber and Plastics Conference paper (multilithographed; available to Aug. 1, 1961).

This is a descriptive review of a new concept in viscoelastic damping material —a resin-based material in trowelable and cured sheet forms. When this combination is applied to structures, it will effectively suppress undesirable resonant vibrations. The high performance level makes the system applicable to such difficult areas of vibration suppression as submarines, ships, large test fixtures, computers, and transformers.

The compound (designated EX-B322) is a resin-based, 100 per cent solid, viscoelastic damping material.

It is available as a trowelable, two-part mastic and as cured modular sections or sheets.

The mastic is a two-part system mixed on the job in a heavy-duty mixer just prior to use. It may be troweled onto clean, dry, vertical surfaces in thick layers (up to $^3/_8$ in.) in one pass without slumping. The applied coating is self-adhering and cures at room temperature, by chemical reaction, to produce an effective damping overlay. Since it contains no solvents, special drying or ventilating equipment is not required.

Damping performance is presented as a function of layer thickness, temperature, frequency, amplitude, and immersion in fluids. Properties and processing, mixing and application of the mastic are described.

Stress-Strain Relations in Cross-Linked Polyethylene..60—RP-14... By I. L. Hopkins and R. P. Wentz, Bell Telephone Laboratories, Inc., Murray Hill, N. J. 1960 ASME Rubber and Plastics Conference paper (multilithographed; available to Aug. 1, 1961).

The main effect of irradiation on polyethylene is a combination of cross-linking and bond scission, with the cross-linking predominating. The result is a material with properties different from those of the parent material and, for some purposes, better.

In its study of the effect of irradiation the Union Carbide Corporation's DYNH polyethylene was cross-linked at room temperature by irradiation and in the melt by means of dicumyl peroxide, and the Phillips Petroleum Company's Marlex 6000 type 50 was cross-linked by irradiation at room temperature. Irradiation was by beta rays (electrons) at one million volts, and was performed at room temperature. The rate of exposure was about seven megarads per min. Four biaxial specimens and five uniaxial at each condition were prepared.

It was concluded that, at ordinary speeds of uniaxial test, Marlex 6000 type 50 is in a critical region between ductile and apparently brittle fracture; biaxially, almost no cold drawing occurs. The lower density, branched DYNH shows no tendency to brittleness in the range of speeds covered. Nevertheless, the unirradiated Marlex requires more total work to rupture the particular biaxial specimen used than does DYNH. Irradiation does not improve Marlex in this respect, although DYNH is improved; in fact, DYNH at 32 megarads is just about equivalent to unirradiated Marlex. But DYNH cross-linked in the melt by 6 per cent of dicumyl peroxide is superior to Marlex and irradiated DYNH by a factor of about $2^1/_2$ in the total work required to rupture the specimen, even though the maximum per unit area is somewhat less.

Novel Designs in Sandwich Structures..60—RP-16... By Andrew C. Marshall, Hexcel Products, Inc., Berkeley, Calif. 1960 ASME Rubber and Plastics Conference paper (multilithographed; available to August 1, 1961).

Over the past 15 years, use of lightweight sandwich structures in airframes has become quite common. During recent years several technological breakthroughs in the field of bonding and a steady improvement in the available component materials have led to a sharp increase in this trend.

Early-day structural sandwich parts were quite simple in concept and suffered from either poor design or gloomy conservatism. Concurrent with improvement in materials and methods of construction, there has been a consistent and sometimes impressive improvement in the quality of sandwich design. It is the purpose of this paper to present some of the outstanding designs produced in the past few years, along with the materials and design philosophies that combined to make them successful.

Magnetic rubber in first and most successful use as a roll covering exhibits holding power with yardstick and wrench (60—RP-17)

Sandwich-design theory, methods of construction, and improvements in component materials are discussed. Outstanding examples of metal-reinforced plastics and mixed sandwich structures are included.

Magnetic Rubber, A New and Useful Material..60—RP-17... By Robert J. Webster, Denman Rubber Manufacturing Company, Warren, Ohio. 1960 ASME Rubber and Plastics Conference paper (multilithographed; available to August 1, 1961).

Recently, a new, flexible, rubbery, magnetic material became available to engineers for use in machines and systems to handle metal strips, shapes, and objects. The author discusses this flexible magnetic rubber, describing characteristics of the material, its present general status in industrial, electronic, and novelty fields, its method of manufacture, and its possibilities and applications, with emphasis on its use as roll covering in steel, steel strip, and metal-handling systems.

Plastic Films Continuously Laminated to Rigid and Semi-Rigid Substrates..60—RP-18... By D. M. Wilkinson, The C. A. Litzler Company, Inc., Cleveland, Ohio. 1960 ASME Rubber and Plastics Conference paper (multilithographed; available to Aug. 1, 1961).

Although many thermoplastic films have been successfully laminated by means of flat-bed presses, the over-all economics and process variables favor the continuous rotary technique. These variables include blistering caused by solvent or water-vapor entrapment and the addition of a balance sheet as a

separate operation to prevent panel warpage.

Because of the great potential in this field, this company developed a two-stage rotary press unit called the Contropress, and later evolved a complete process line for handling rigid and semi-rigid substrates.

The paper describes the continuous application of plastic films to discontinuous or continuous substrates for horizontal or vertical applications, either decorative or functional. It describes the applications of both supported and unsupported films either clear, printed, or opaque, and describes the adhesive system and subsequent processing to be used for each combination.

Elastomers Applied to Structural Damping..60—RP-19... By Bruce W. Campbell, Assoc. Mem. ASME, Lord Manufacturing Company, Erie, Pa. 1960 ASME Rubber and Plastics Conference paper (multilithographed; available to Aug. 1, 1961).

Modern propulsion systems and high-speed flight produce high-intensity sound fields generally random in nature over an extended frequency range. Such excitations produce resonant responses, leading to structural fatigue and equipment malfunction that cannot be avoided or easily isolated.

Sonically induced fatigue can be reduced by increasing the strength of conventional designs to carry the additional dynamic loads. However, such treatment results in a structure much stronger than that required from static loading considerations and with a corresponding extreme increase in weight. This weight penalty is generally prohibitive and the designers are faced with finding another solution to the problem.

Resonant and transient response of many mechanical systems has been controlled by the addition of damping.

Present-day damping treatments involve the addition of materials with viscoelastic properties to existing structural designs.

The material described in this paper has many of the properties required of an "ideal" material as well as areas in which improvement can be sought.

Petroleum

Design Against Excessive Plastic Deformation..60—Pet-2... By W. P. Kerkhof, Bataafs Internationale Petroleum Maatschappij N. V. (Royal Dutch/Shell Group, The Hague). 1960 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1961).

Following the program of commission XI of the International Institute of Welding, a study has been made on excessive plastic deformation. It was found that a close relation exists between plastic deformation and other phenomena, such as high strain fatigue, brittle rupture, and corrosion, which makes it impossible to solve the problems for the time being. However, an approximation was found, enabling the designer to measure the allowable stress ranges on models and in some cases to calculate them. Some examples of the calculation prove that the results are in very good agreement with established practice.

The steel of vessels built according to these methods does not lose its ductility during service. Consequently, there need be no fear of corrosion or brittle rupture as a result of changes in mechanical properties of the material in service. The method mentioned at the same time limits the stress range in such a way that high-strain fatigue does not occur in the standard materials mentioned. This is proved by comparing the results of the proposed method with acknowledged practice, in this case, German practice. For nonstandard materials, such as modern high tensile quenched and tempered steels, a comparison with good practice is impossible so that for such steels the method is not recommended for the time being.

It is also shown that henceforward shells can be made thinner if manufacture improves, without increasing the permissible stress range.

In addition, the author presents a discussion of corrosion as it relates to plastic deformation; a calculation of a cylindrical shell of a standard vessel subjected to internal pressure, and of tolerances on out-of-roundness for cylinders under internal pressure; and discussions of stress ranges in torispherical ends, and high-strain fatigue.

Design Data for Pipeline Branch Connections..60—Pet-21... By T. J. Atterbury, Assoc. Mem. ASME, and G. M. McClure, Battelle Memorial Institute, Columbus, Ohio. 1960 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1961).

A pipeline branch connection in its simplest form is just the intersection of two right circular shells. Yet, the problem of designing the intersection of two cylindrical shells to withstand the same operating pressure as the shells themselves is rather complex. No three-dimensional theory has yet been found which adequately describes the stresses in the region of a branch connection in either the unreinforced or reinforced condition.

Presented are the results of a series of experiments designed to provide information on the effects of the basic dimensional parameter on maximum stresses and stress distribution in pipeline branch connections. A semiempirical method is proposed which allows reinforcement thickness to be calculated from chosen design stresses and the dimensions of a branch connection.

High-Temperature Stability of Tubular Products for Oil-Refinery Use..60—Pet-22... By A. B. Wilder and D. T. Boughner, United States Steel Corporation, Pittsburgh, Pa.; E. F. Ketterer and D. B. Collyer, Lorain Works, United States Steel Corporation, Lorain, Ohio. 1960 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1961).

A group of 138 different steels were exposed for periods up to 100,000 hr at 900, 1050, and 1200 F without stress. Results presented in this paper are those from typical steels for oil-refinery use that were exposed from 10,000 to 83,000 hr in laboratory tests. The data include tensile, creep rupture, hardness, oxidation characteristics, impact properties, and microstructure. Weld-bead tests are also included in the investigation and are examined metallographically. The data indicate stability characteristics of the materials tested.

Supercompressibility Factors for Gas Pipeline Measurement Automation..60—Pet-23... By Edward Gordon, United Gas Corporation, Shreveport, La. 1960 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1961).

The American Gas Association Gas Measurement Committee Report No. 3, "Orifice Metering of Natural Gas," contains a table of values of Supercompressibility Factors (Table 16A) which were recommended for orifice-meter calculations. This table contains an entry for every pressure from 0 psig to 3000 psig in steps of 20 psi and at every temperature from −40 to 185 F in steps of 5 deg for a total of 6946 entries. All of the procedure recommended for orifice-meter calculations can easily be programmed efficiently for almost any digital computer except for the supercompressibility factors, F_{pv}, as they are defined by Table 16A.

The author describes an approach using a single equation relating to the behavior of the supercompressibility factor for all temperatures and at all pressures up through 1200 psig. This equation is compared with the supercompressibility factor in Table 16A. A second equation also has been developed for use with pressures up through 1500 psig. The author discusses the convenience of these equations in developing computer programs, and their small deviations from standard values in Table 16A.

The Effects of Internal Pressure on Thin-Shell Pressure Vessel Heads..60—Pet-41...By Edward O. Jones, Jr., Auburn University, Auburn, Ala. 1960 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1961).

Two pressure vessels were used to determine experimentally the shell-to-head junction stresses for certain steel thin-shell pressure vessels. The types of heads used during the study were a torispherical head, a two-to-one ellipsoidal head, a 90-deg toriconical head, and a 120-deg toriconical head. The test vessels used were commercial type vessels and the internal pressures did not exceed 15 psi.

The information gained during this investigation can be used in checking the validity of certain pressure-vessel-stress theories. It is hoped that it will also prove to be useful in the design of thin-shell pressure vessels.

ASME TRANSACTIONS

Journal of Heat Transfer

The February, 1961, issues of the Transactions of the ASME—*Journal of Heat Transfer* and *Journal of Engineering for Industry* (available at $1.50 per copy to ASME Members, $3 to nonmembers) contain the following:

A Survey of P-V-T Data for Water in the Critical Region, by E. S. Nowak, R. J. Grosh, and P. E. Liley. (60—HT-25)

Smoothed Pressure-Volume-Temperature Data for Water in the Critical Region Derived From Experimental Measurements, by E. S. Nowak, R. J. Grosh, and P. E. Liley. (60—HT-26)

Experimental Determination of Limit of Supersaturation of Nitrogen Vapor Expanding in a Nozzle, by G. L. Goglia and G. J. Van Wylen. (60—SA-8)

Some Temperature and Pressure Measurements in Confined Vortex Fields, by J. M. Savino and R. G. Ragsdale. (60—SA-4)

The Influence of Bypass Channels on the Laminar Flow Heat-Transfer and Fluid Friction Characteristics of Shell and Tube Heat Exchangers, by Frederick L. Test. (60—SA-7)

An Analytical Study of Laminar Film Condensation: Part 1—Flat Plates, by Michael Ming Chen. (60—HT-37)

An Analytical Study of Laminar Film Condensation: Part 2—Single and Multiple Horizontal Tubes, by Michael Ming Chen. (60—HT-38)

Transient Natural Convection From Vertical Elements, by B. Gebhart. (60—HT-33)

Determination of Boiling Film Coefficient for a Heated Horizontal Tube in Water-Saturated Wick Material, by W. D. Allingham and J. A. McEntire. (60—HT-11)

Optimization of a Sandwiched Thermoelectric Device, by B. W. Swanson, E. V. Somers, and R. R. Herkes. (60—HT-24)

The Heat-Balance Integral—Further Considerations and Refinements, by T. R. Goodman. (60—SA-9)

Effect of Aspect Ratio and Tube Orientation on Free Convection Heat Transfer to Water and Mercury in Enclosed Circular Tubes, by F. W. Larsen and J. P. Hartnett. (60—SA-21)

Technical Briefs

A Note on the "Implicit" Method for Finite-Difference Heat-Transfer Calculations, by G. M. Dusinberre.

The Influence of Prandtl Number on the Heat Transfer From Rotating Nonisothermal Disks and Cones, by J. P. Hartnett and E. C. Deland.

A Fully Integrated Solution of the Problem of Laminar or Turbulent Flow in a Tube With Arbitrary Wall Heat Flux, by R. N. Noyes.

The Leveque Solution With a Finite Wall Resistance, by E. M. Rosen and E. J. Scott.

Condensation on a Rotating Cone, by E. M. Sparrow and J. P. Hartnett.

Refrigerator Heat Leak for Sandwiched Thermoelectric Elements, by B. W. Swanson and E. V. Somers.

Journal of Engineering for Industry

A Systems Analysis of Fast Manned Flights to Venus and Mars, Part I, by K. A. Ehricke. (60—Av-1)

A Systems Analysis of Fast Manned Flights to Venus and Mars, Part II, by K. A. Ehricke.

Stresses in Thin-Walled Pressure Vessels With Ellipsoidal Heads, by H. Kraus, G. G. Bilodeau, and B. F. Langer. (60—SA-12)

An Analysis of the Yielded Compound Cylinder, by S. J. Becker. (60—SA-13)

On the Use of Clearance in Viscous Dampers to Limit High Frequency Force Transmission, by M. E. Gurtin. (60—SA-17)

Analysis and Design of Tangent Elasticity Vibration Isolators, by J. E. Ruzicka. (60—SA-5)

Analysis of Buckling Column Spring With Pivoted Ends and Uniform Rectangular Cross Section, by Alexander Blake. (60—SA-10)

The Vibration of Shaft Ropes With Time-Variable Length, Treated by Means of Riemann's Method, by W. J. Schaffers. (60—SA-16)

Studies of the Design of Steel Castings and Steel Weldments as Related to Methods of Their Manufacture, by H. R. Nara, D. K. Wright, Jr., and C. W. Briggs. (60—SA-2)

Design of Flapper Valves, by P. R. Paslay. (60—SA-3)

The Free Expansion of Dry and Moist Air, by J. H. Potter and M. J. Levy. (60—SA-23)

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COMMENTS ON PAPERS

Presenting a Paper? Here's How

To the Editor:

DURING the past 10 or 15 years, ever since the majority of the papers presented at meetings of engineering societies became the result of organized, sponsored research rather than individual spare-time efforts, the presentation of papers has become more elaborate, more formal, more visual than oral, and—unfortunately, in too many cases—less interesting. This is not to say that the technical level of the papers has deteriorated, for quite the contrary is true. The manner of presentation, however, is no longer geared to a listener but to a reader instead.

For example, at the 1961 ASME Winter Annual Meeting, like at similar meetings of ASME and other engineering societies, I sat through interminable hours in dark rooms being lulled to sleep by the monotonous soliloquy of the speaker. He had trouble reading his lecture notes in the dark which was relieved by a single bulb illuminating the speaker's chin rather than his manuscript. He was running back and forth between the screen and the lectern, and the sound would fade in and out as he was approaching or going away from the microphone. Three-quarters of the audience were asleep, the remainder were awake because (1) they had just had a strong cup of coffee, (2) they were talking to their neighbors, (3) they were getting up to leave the room, (4) they were speakers scheduled to follow the present speaker and did not want to miss their cues, (5) they were chairing the meeting and valiantly tried, sometimes unsuccessfully, to stay awake.

The speaker did not have the slightest inkling that three-quarters of his audience were asleep since the darkness made it impossible for him to communicate with his audience effectively. At the end of his talk the lights would go on; this and the applause of the few awake members of the audience would briefly rouse the slumbering majority. They did not have to stay awake for long, though, since the next speaker swiftly had the lights turned off after the first few sentences of his talk.

This description may strike some people as either humorous or exaggerated but, unfortunately, it is neither. If the considerable expense in time and money on the part of the Society and the attendees at these conventions is considered, this method of transmitting technical information at meetings seems highly inefficient.

The following suggestions are made with the intent of improving the communication between speaker and audience and thereby increasing the usefulness of technical lectures.

1 Remember That You Are Delivering a "Talk," not a "Paper." By presenting your work in person you undertake the responsibility of communicating verbally with your listeners. Therefore, do not read your formal written paper to them. They can all read.

2 Look at Your Audience. Any radio or TV actor can tell you how difficult it is to speak to an unseen audience. You do not have to work under this handicap if you keep the lights on throughout your lecture room and stay away from the distractions of the projection screen which forces you to turn away from your audience.

3 Keep the Number of Slides to a Minimum. Slides should not be used for giving an outline of your talk, for boring your audience with the intricacies of mathematical derivations, or for presenting a wealth of test data.

If a great many data are significant, they should be digested at the reader's leisure and not within a fraction of a minute during which they are flashed on the projection screen. If there are only a few significant data, what is wrong with giving them verbally? Not all of us have lost the ability to absorb the spoken word.

If the details of the mathematics are really interesting, they deserve more study than can be given on the screen. If you want to outline the method only, the spoken word is far more effective in doing that than a bunch of equations thrown at an audience unfamiliar with them.

4 If You Have to, Use Few, Simple Slides. Slides are suitable for showing entire structures, complicated pieces of equipment, and for the comparison of date, i.e., graphs. Their judicious use can greatly enhance the value and understanding of a talk. But remember, the slides are an auxiliary to your talk, and not vice versa. Do not let your talk become a commentary on your slides.

5 Leave the Lights on While You Show the Slides. This is the easiest remedy for the worst drawback of most current talks. A suitable, simple slide shows a clear photograph or a plot drawn with heavy lines accompanied by a minimum of text. Such a slide, properly prepared, can be seen clearly with most projection equipment if the lights in the room are kept on at normal strength or slightly dimmed. By keeping the room lighted you avoid losing your listeners through darkness-induced slumber. You maintain contact with them by being able to see and talk to them as individuals rather than an amorphous mass somewhere beyond you in the dark.

Next time you give a talk, try these few, simple rules, and you will be surprised at the difference which the presence of a live, wide-awake audience makes on your presentation.

Harold G. Lorsch.[1]

[1] Space Structures Operation, Space Sciences Laboratory, General Electric Company, Philadelphia, Pa.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

Some Observations Relating to S. Carnot's Reflections on the Motive Power of Heat

By G. B. Warren[1]

Reflections on the Motive Power of Heat—and on machines fitted to develop this power. Translated by R. H. Thurston.

By S. Carnot. The American Society of Mechanical Engineers, New York, N. Y., 1943; Second Printing, 1960. Cloth 5¾ in. × 9 in., illus., 107 pp., $3, with a 20 per cent discount for members of ASME.

THIS book was first published in 1824 by a young man but 28 years old at the time. The original French text was translated in 1890 by R. M. Thurston, the first President of the ASME. It was published by the ASME in 1942 with an introduction by Prof. A. G. Christie, and was published in a new edition by the ASME in 1960.

Professor Christie in writing the introduction of the first edition calls attention to the farsighted engineering vision of Carnot when he writes: "An engineer will find much of secondary interest in Carnot's book. For instance, he seemed familiar with the development of the steam engine by English engineers and the efficiencies obtained. He speaks of the highest steam pressures as 6 atmospheres, and condensation temperatures of 40 C (104 F) corresponding to 27.8 in. vacuum. Carnot has a clear conception of the value of feedwater heating which he describes in several paragraphs. One is surprised to find in the latter part of his essay a clear conception of the cycle of the combustion gas turbine, which is only now undergoing commercial development."

The genius and foresight of Carnot can be even more strikingly understood by the following quotations from the text. For example, as to the value of higher pressures: "It is easy to see the advantages possessed by high-pressure machines (engines) over those of lower pressure. This superiority lies essentially in the power of utilizing a greater fall of caloric (heat.) The steam produced under a higher pressure is found at a higher temperature, and as, further, the temperature of condensation remains always about the same, it is evident that the fall of caloric is more considerable. . . . A good steam engine, therefore, should not only employ steam under heavy pressure, but under successive and very variable pressures, differing greatly from one another, and progressively decreasing."

Then his understanding of the value of a cycle using other potential fluids: "If we could find an abundant liquid body which would vaporize at a higher temperature than water, of which the vapor would have, for the same volume a less specific heat, which would not attack the metals employed in the construction of the machines, it would undoubtedly merit the preference. But nature provides no such body." It is somewhat difficult to reconcile his last sentence here with his earlier view on page 51, where he states, "Vapors of all substances capable of passing into a gaseous condition, as of alcohol, of mercury, of sulphur, etc., may fulfill the same office as vapor of water . . . . Most of these substances have been proposed, many even have been tried, although up to this time perhaps without remarkable success."

Then he beautifully visualized the regenerative steam cycle when after remarking on page 58 that "contact between bodies of different temperature . . . . results" in a "loss of motive power" and then he adds a footnote: "This kind of loss is found in all steam engines. In fact, the water destined to feed the boiler is always cooler than the water which it already contains. There occurs between them a useless re-establishment of equilibrium of caloric. We are easily convinced . . . . that this re-establishment of equilibrium causes a loss of motive power if we reflect that it would have been possible to previously heat the feedwater by using it as condensing water in a small accessory engine, when the steam drawn from the large boiler might have been used, and where the condensation might be produced at a temperature intermediate between that of the boiler and that of the principal condenser. The power produced by the small engine would cost no loss of heat, since all that which had been used would have returned into the boiler with the water of condensation." (This is, of course, not strictly true in view of our present knowledge of thermodynamics, but it is basically sound reasoning.)

He further visualizes the internal-combustion engine when on page 102 he states: "We have, further, only a few remarks to make upon the use of permanent gases and other vapors than that of water in the development of the motive power of heat.

"Vapors of water can be formed only through the intervention of a boiler, while atmospheric air could be heated directly by combustion carried on within its own mass. Considerable loss could thus be prevented, not only in the quantity of heat, but also in its temperature. This advantage belongs exclusively to atmospheric air.

"In order to give to air great increase in volume, and by that expansion to produce a great change in temperature, it must first be taken under a sufficiently high pressure; then it must be compressed with a pump or by some other means before heating it. This operation would require a special apparatus, an apparatus not found in steam engines. In the latter, water is in a liquid state

[1] Retired vice-president, General Electric Company, and consulting engineer, Turbine Division, Schenectady, N. Y. Past-president and Fellow ASME.

when injected into the boiler, and to introduce it requires but a small pump.

"One of the gravest inconveniences of steam is that it cannot be used at high temperatures without necessitating the use of vessels of extraordinary strength. It is not so with air for which there exists no necessary relation between the elastic force and the temperature. Air, then, would seem more suitable than steam to realize the motive power of falls of caloric from high temperatures."

And then he pictures the compound cycle between the internal-combustion air cycle and the closed steam cycle which is just now coming into practice: "Perhaps in low temperatures steam may be more convenient. We might conceive even the possibility of making the same heat act successively upon air and vapor of water. It would be only necessary that the air should have, after its use, an elevated temperature, and instead of throwing it out immediately into the atmosphere, to make it envelop a steam-boiler, as if it issued directly from a furnace.

"The use of atmospheric air for the development of the motive power of heat presents in practice very great, but perhaps not insurmountable, difficulties. If we should succeed in overcoming them, it would doubtless offer a notable advantage over vapor of water."

"It is thus upon the use of atmospheric air and vapor of water that subsequent attempts to perfect heat engines should be based."

It is rare indeed that any engineer can see the future developments through a century and a half as clearly.

BOOKS RECEIVED IN LIBRARY

Mecanique Non Linéaire

By A. Blaquière. 1960, Gauthier-Villars, Paris, France. 137 p., $6^1/_4 \times 9^1/_2$ in., paper. $5.75. The author presents an operational method for the analysis of nonlinear systems deriving from Poincaré's methods of approximation by series developments. The method is related to current methods in linear mechanics and the adiabatic hypothesis employed by physicists. The exposition includes an introductory section tracing the development of analytical methods in nonlinear mechanics. The remainder is arranged in three steps—free oscillations in nonlinear systems; sinusoidal excitation of nonlinear systems; random excitation of nonlinear systems.

Mehrspindel-Automaten

By H. Finkelnburg. Second Edition. 1960, Springer-Verlag, Berlin, Germany. 315 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 49.50. The development, types, range of operation, selection, and regulation of multispindle automatic machine tools are discussed. The machinery itself is fully described, the calculation and method of production of the necessary motions are considered, and the final section deals with auxiliary tools and special equipment.

Metallic Corrosion Inhibitors

By I. N. Putilova and others. 1960, Pergamon Press, Inc., New York, N. Y. 196 p., $5^1/_2 \times 8^3/_4$ in., bound. $10. A translation of a Russian monograph intended to systematize and generalize available information on the theory and practice of applying corrosion inhibitors. General theoretical problems of corrosion are not discussed. Includes classification of inhibitors and the laws governing their action, concepts of the mechanism of protective action of inhibitors, and detailed discussion of inhibitors of atmospheric corrosion, and in solutions of acids and alkalies, in water, and in aqueous solutions of salts. Appendixes contain information on pickling, boiler cleaning, and rust removal, and there is a useful index of inhibitors.

Methods and Techniques in Geophysics, Vol. 1

Edited by S. K. Runcorn. 1960, Interscience Publishers, Inc., New York, N. Y. 374 p., $6^1/_4 \times 9^1/_4$ in., bound. $10. A collection of papers dealing with modern physical techniques employed in determining and dealing with physical information about the earth. Contributors from the U. S., Canada, and Britain discuss measurement of temperature gradient in the earth, heat flow over land, geomagnetic elements, gravity at sea, and in palaeomagnetism; earth currents and the detection of earth movements; borehole surveying; properties of rock under high temperature and pressure; and the latitude, longitude, and secular motion of the pole.

The Natural Gas Industry

By Edward J. Neuner. 1960, University of Oklahoma Press, Norman, Okla. 302 p., $6^1/_4 \times 9^1/_4$ in., bound. $5.75. The objective of this study is to provide factual and analytical materials needed for a rational policy decision and to offer a policy judgment on the monopoly issue in natural gas production. The fulfillment of this aim is sought by an investigation of natural gas field markets over the period 1945–1953, during which time a major postwar expansion of the industry took place. Part 1 develops basic factual information about concentration, field-price levels, and field-market practices. Part 2 explores market behavior in the gas field through a systematic examination of market transactions. Part 3 undertakes to evaluate the case for and against gas-field monopoly.

Physics of the Upper Atmosphere

Edited by J. A. Ratcliffe. 1960, Academic Press, Inc., New York 3, N. Y. 586 p., $6^1/_4 \times 9^1/_4$ in., bound. $14.50. Eleven chapters of this book are detailed monographs on particular topics by specialists, all concerned with that part of the atmosphere above the height of 60km. These deal with the thermosphere, the ionosphere, the properties and constitution of the upper atmosphere and its study by rockets and satellites, the airglow, general characteristics of auroras and their study by means of radar, interpretation of the auroral spectrum, and consideration of geomagnetism and meteors in the upper atmosphere. The final chapter contains brief comment on advances during the IGY 1957/1958 in each field, written by the author of the relevant chapter of this book.

Progress in Cryogenics, Vol. 2

Edited by K. Mendelssohn. 1960, Academic Press, Inc., New York, N. Y. 280 p., $6^1/_4 \times 10$ in., bound. $11.50. Vol. 2 of the series summarizing articles on the whole field of low-temperature methods and techniques, as distinguished from low-temperature physics or chemistry. This volume presents papers on the storage and handling of cryogenic liquids, the gas refrigerating machine; bubble chambers; resistance thermometers; the three-level solid-state maser; methods of nuclear orientation; the 1958 scale of temperatures for the liquid Helium-4 region; and industrial low-temperature distillation for Deuterium.

Progress in Non-Destructive Testing, Vol. 2

Edited by E. G. Stanford and J. H. Fearon. 1960, The Macmillan Company, New York, N. Y. 250 p., $6^1/_4 \times 10$ in., bound. $12. This is the second volume in a series of annual critical reviews on international progress in nondestructive testing. Papers included cover the uses of radiology with high-energy x rays, electrical methods, radioisotopes, ultrasonic waves, and paramagnetic resonance in this type of testing. The theory and practical application of these methods of studying and detecting flaws in metal structure are presented, as well as studies of ageing and precipitation in metals using anelastic damping measurements. The mechanical testing of high polymers is also dealt with.

Public Relations and Management

By David Finn. 1960, Reinhold Publishing Corporation, New York, N. Y. 175 p., $5^1/_4 \times 7^3/_4$ in., bound. $4.50. This is an outline of the potentialities and limitations of public relations for industry, as managers should understand them. The text describes how public relations fits into the management scheme, explains how it works, and examines methods of appraisal and control.

Reactor Handbook, Vol. 1: Materials

Edited by C. R. Tipton, Jr. Second Edition. 1960, Interscience Publishers, Inc., New York, N. Y. 1207 p., $7^1/_2 \times 10$ in., bound. $36.50. This revised compilation of data on reactor materials is organized along the lines of the functional utilization of the materials within a reactor, thus extending the coverage to include liquids and gases as well as solids. Other additions include information from the results of research published since 1955, including that on irradiation behavior. The contributors are American, but international research and literature has been used as source material. A general section contains papers on health, safety, and radiation damage. The other sections cover fuel materials; cladding and structural materials; control materials; moderator materials; coolant materials;

shielding materials. The 32-page appendix is a selected list of literature references on binary constitutional diagrams.

Statistical Processes and Reliability Engineering

By Dimitris N. Chorafas. 1960, D. Van Nostrand Co., Inc., Princeton, N. J. 438 p., $6^1/_4 \times 9^1/_4$ in., bound. $12.75. This book treats statistics as a fundamental tool of scientific investigation, presenting and explaining its laws, and its relationships with engineering disciplines and practices. A systematic and mathematically complete presentation of statistical techniques is followed by discussion of statistical methods in the testing of hypotheses. The next three sections of the book describe in detail stochastic processes, information processes, and quality control. The final section, the climax of the whole discussion, considers the use of probability theory in designing for reliability and in reliability tests of products—that is, "reliability engineering."

Symposium on Effect of Water-Reducing Admixtures and Set-Retarding Admixtures on Properties of Concrete

Published 1960 as ASTM Special Technical Publication No. 266, by the American Society for Testing Materials, Philadelphia, Pa. 246 p., $6 \times 9^1/_4$ in., bound. $7.50. Initiated to promote increased understanding of concreting materials and the best manner of combining them to produce the maximum in strength and durability, this symposium consisted of ten papers and a summary, published herein. Topics discussed include effects of admixtures on plastic, hardened, ready-mixed, structural, and lean-mass concrete; the uses, specifications for, and research objectives in admixtures; admixtures and Portland cement pastes and composition; definition of and functional differences between admixtures; testing and use of water-reducing retarders; and detection of lignosulfonate retarder in cement suspensions and paste.

Taschenbuch des Metallschutzes

By W. Wiederholt and J. Elze. 1960, Wissenschaftliche Verlagsgesellschaft abH, Stuttgart, Germany. 900 p., $5 \times 6^3/_4$ in., bound. DM 78.00. This pocketbook begins with the fundamental aspects of protection against corrosion. Attempt also is made to present the manifold protection methods in order to facilitate the selection of the best, from both the technical and economic viewpoint, for the practicing engineer. The contents include such topics as active and passive corrosion protection, testing of corrosion resistance, practice of corrosion testing, protection against accidents, etc. There is an extensive bibliography of 85 pages, arranged according to chapters, and a detailed subject index is provided.

Technical Communication

By George C. Harwell. 1960, The Macmillan Company, New York, N. Y. 332 p., $6 \times 8^1/_4$ in., bound. $5. Written with the engineering student in mind, this book will also be useful to the practicing engineer and those in some other professions. The first three chapters discuss the qualities of good writing, the organization of material, and the use of exposition. The business letter is covered in detail. There is an extended treatment of reports and information on technical articles, magazine writing, oral communication, and the use and preparation of tables and figures. The final section of the book is a manual of general composition, containing a review of the general principles of composition, and a glossary of usage.

LIBRARY SERVICES

Engineering Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by ASME members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Theory of Detonation

By Ia. B. Zeldovich and A. S. Kompanseets. 1960, Academic Press, Inc., New York, N. Y. 284 p., $6 \times 9^1/_4$ in., bound. $10. This book is based on research performed at the Chemical Physics Institute of the Academy of Sciences of the USSR, and presents systematically the hydrodynamic theory of detonation. The discussion follows a topical arrangement beginning with the elements of gas dynamics, moving to consideration of the detonation regime and lossless combustion, then presenting the theory of detonation and discussing losses, the limits of detonation, detonation of condensed explosives, and the motion of the detonation products.

Theory of Thermal Stresses

By Bruno A. Boley and Jerome H. Weiner. 1960, John Wiley & Sons, Inc., New York N. Y. 586 p., $6 \times 9^1/_4$ in., bound. $15.50. The author first develops the fundamentals of thermoelasticity, working from the thermodynamic foundations to various alternate formulations and problem-solution methods. Three chapters then discuss the physical basis of heat-transfer theory and methods of solution of heat-conduction boundary-value problems. Part three of the book then covers practical aspects of thermal stress analysis, mainly from the strength-of-materials viewpoint. The final section describes the manner in which temperature effects can be included in elasticity theory, covering the general nature of the idealizations used in this field, problems utilizing these idealizations, and problems involving plastic flow.

The Theory of Linear Viscoelasticity

By D. R. Bland. 1960, Pergamon Press, Inc., New York, N. Y. 125 p., $5^1/ \times 8^1/$ in., bound. $7.50. This book contains an introduction to the concepts of the subject, making use of one-dimensional models, a derivation of the various equivalent forms of the stress-strain equations, and of the associated potential and dissipation functions; and treats problems in stress analysis for sinusoidal oscillations, for quasistatic and for dynamic conditions, respectively. Model fitting also is discussed.

Thermal Engineering

By Harry L. Solberg. 1960, John Wiley & Sons, Inc., New York, N. Y. 649 p., $6^1/_4 \times 9^1/_2$ in., bound. This book is designed to serve as a supplement to thermodynamic texts which give inadequate reference to the equipment used for the generation of power, and refrigeration. It describes principles of construction, operation, and performance of the major components of a thermal power-generating system, emphasizing application of the energy and material balances, and presenting a balanced treatment of fossil and nuclear fuels as sources of energy, the reactions by which energy is released in them, and the manner in which part of this energy is converted into work. The book includes chapters on power-plant cycles, steam generation and heat transfer, heat exchangers, turbines, pumps, fans, blowers, and compressors.

Ultimate Moments and Shears in Continuous Reinforced Concrete Beams

By George C. Ernst. 1960, The University of Michigan Press, Ann Arbor, Mich. 37 p., $6^1/_2 \times 9^3/_4$ in., bound. $4. This monograph considers the development of ultimate moments and shears in continuous reinforced concrete beams under loads producing conditions of structural collapse. Part A discusses the relationships of a purely theoretical character, and Part B all experimental results from tests, with comparisons to theory. The theory is restricted to the particular loading conditions of the tests, but can be extended to other conditions of loading and to other structures.

Using Centrifugal Pumps

By E. Allen. 1960, Oxford University Press, New York, N. Y. 246 p., $5^1/_4 \times 8^3/_4$ in., bound. $4.80. This book deals with the centrifugal pump from the user's point of view and more particularly from that of the operating and maintenance staff responsible for the efficient running and daily care of pumps, and their emergency repair or installation. Fundamental principles are dealt with, pump characteristics explained, and numerous examples given of methods of correctly choosing type and capacity for both permanent and emergency needs.

Welding Handbook, Section Three: Miscellaneous Metal Joining and Cutting Processes

Edited by Arthur L. Phillips. Fourth Edition. 1959, American Welding Society, New York, N. Y. Various pagings, $6 \times 9^1/_4$ in., bound. $9. Inclusion of chapters on the adhesive bonding of metals and the welding of plastics in this handbook marks the recognition by the AWS of adhesives as structural materials and of plastics as weldable materials. Other topics covered include forge, thermit, induction, ultrasonic, and stud welding, welding by cold working, surfacing, brazing, soldering, arc and oxygen cutting, and metal and ceramic spraying. Section 1 of the Handbook—General; Section 2—Gas, arc and resistance welding processes; Sections 4 and 5 to follow.

American Society of Tool and Manufacturing Engineers, Collected Papers, 1960

Published 1960 by the ASTME, Detroit, Mich. 302 p., $8^1/_2 \times 11$ in., paper. No price given. ASTME publishes its conference papers annually in two volumes to correspond to the spring and the fall meetings. This first volume for 1960 contains 65 papers. Nearly half of the papers are concerned with various aspects of planning, control, and automation in manufacturing, though they are grouped in no less than five ostensibly unique sections such as "product engineering," "process engineering," and "manufacturing management." Other papers deal with dimensional metrology, metal cutting and forming, and heat-treating: One paper examines professional engineering and the position of the tool engineer, and a group of interesting general papers discuss tooling for the handicapped and other challenges for the engineer in vocational rehabilitation, and the "impossibility of communication."

Current Engineering: Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

Aluminum—75 Years From Discovery to Major Industry

Tribute paid to C. M. Hall, discoverer of process that made aluminum commercially abundant

THE seventy-fifth anniversary of the process discovered by Charles Martin Hall that made aluminum available throughout the world was celebrated at Oberlin College on February 16, under the sponsorship of The Aluminum Association. The discussion based on aluminum's role in the world of the future featured a round-table forum on "Tomorrow." Philip Sporn, Hon. Mem. ASME, was one of the panelists.

The observance marked the anniversary of Hall's discovery, Feb. 23, 1886, of the electrolytic process which first made aluminum commercially abundant. He was 22 years of age and a recent graduate of Oberlin College when he scored his triumph. Before his discovery, aluminum was so rare that jewelry was made of it. In 1960 the United States production of aluminum exceeded two-million tons.

While aluminum had been isolated nearly a century before, its economical, large-scale production had defied the best brains of science. Mr. Hall ushered in the Aluminum Age, touched off a metallurgical revolution, and gave to mankind a new material destined for an almost infinite number of uses in building, transportation, home appliances, communication, and agriculture.

Versatility is one of the qualities that has boomed aluminum from a "new discovery" to a major strategic industry in scarcely 75 years.

Today in the U. S., six primary producers operate 22 reduction plants near sources of hydroelectric and thermally generated power in 13 states. Their aggregate production reached a record high of 2,014,499 tons in 1960, and their productive capacity stands at 2,468,750 tons. This tremendous potential—the largest in the world—is more than ten times that of 20 years ago.

Many of the uses and most of the current consumption are concentrated in a half-dozen fields of application. Building construction, foremost consumer, has taken about a quarter of the wrought aluminum output every year since 1946.

Aluminum Memorial. Statue of Charles Martin Hall, discoverer of the electrolytic reduction process for aluminum, at Severance Chemical Lab, Oberlin College. He was graduated from Oberlin on July 1, 1885. His discovery was made in the woodshed of his family home in Oberlin, Feb. 23, 1886. Aluminum statue was presented to Oberlin, in 1928, by Richard B. Mellon.

While nearly all forms of transportation are partly dependent on aluminum, aircraft and autos are the major users. Five car models are being offered with aluminum engine blocks this year, and every American auto sold features aluminum engine parts, housings, and trim. Estimates set aluminum use per 1961 car at an average of 63 pounds.

Since Hall's discovery, electricity has been one of the indispensable "raw materials" of the aluminum industry; it takes $8\frac{1}{2}$ kwhr of electricity to produce a pound of aluminum. In recent years the electrical industry has become one of the leading users of the metal it helps to produce.

Appliances and equipment around the house take a substantial share of U. S. aluminum. Oldest and most familiar use of aluminum is, of course, in cooking utensils and kitchen wares where natural brightness is desirable and nontoxicity essential.

One of the more dynamic markets for aluminum well known to nonindustrial consumers is packaging, ranking fifth as a user of aluminum, mostly in the form of foil. Aluminum foil is substantially sterile as it leaves the rolling mills, can be further sterilized, and gives no color, odor, or taste to the product it encloses.

There are many other market areas which have taken mounting tonnages of the plentiful aluminum supply; pipe for irrigation, equipment for the food and chemical processing industries, textile machinery, and machine components where nonsparking or nonmagnetic characteristics are essential for safety.

The industry has had to prove the economies of aluminum through market research and product development. Basic research in alloys, metalworking, and finishes have brought new utility to the metal and encouraged new uses which would not have been possible a dozen years ago. Per-capita use of aluminum in the U. S. last year was 23 pounds, twice the average for all the European countries.

The total output of aluminum available for consumption in America's expanding markets does not end with the virgin ingot poured at the nation's reduction plants; a considerable part of the total supply comes from many secondary smelters in the form of alloy ingot recovered from scrap. It is this pool of prime and alloy ingot which goes to the semifabricators who turn out the various manufactured forms of aluminum—the commodities produced by rolling, extruding, drawing, casting, and forgings. Eventually, these wrought and cast commodities become the raw material for manufactured products of over 25,000 light metal-consuming industries in the United States.

ECPD Seeks Aid in Furthering Engineering Guidance Program

Our technological progress and economic growth require the services of ever larger numbers of engineers to work in industry, education, government, and private practice. The first step toward achieving a greater number of engineers to meet future needs is to attract additional qualified high-school students to the study of engineering. This objective is being carried out by the Guidance Committee of the Engineers' Council for Professional Development (ECPD) through a network of state committees which work directly with the schools.

Each year, a great many engineers from the ECPD State Committees visit high schools across the country to tell the students about engineering and the aptitudes and preparation required for a career in this field. Through special projects and meetings, vocational counselors, mathematics and science teachers, and parents of high-school students also are told about engineering and the career opportunities the profession offers to qualified students. The help of more engineers is needed to further develop and expand the ECPD guidance program.

The ECPD State Committees were organized during the Korean War when the shortage of engineers was reaching critical proportions. There are now committees in all 50 states, the District of Columbia, and Canada. The work is co-ordinated by the ECPD National Guidance Committee through eight Region Chairmen.

In the past, individuals and local groups of engineers have undertaken engineering guidance work unaware of the role exercised by ECPD as co-ordinator. Result: Difficulties with school authorities because of duplication in school contacts and uneven standards in the conduct of the work. For a unified approach to the recruitment question, engineers interested in guidance are asked to join in the ECPD program, rather than in independent programs.

The ECPD State Committees arouse interest in engineering through a variety of programs which include talks and panel presentations, films on engineering, inspection trips, promotion of high-school engineering clubs and science fairs, television and radio programs, individual counseling, and many other activities. National Engineers' Week is used by many committees as a focal point for special guidance projects. Committees change and modify their programs each year as new ideas are tried out.

The ECPD National Guidance Committee supports the work of the State Committees through two annual mailings to the nation's 30,000 high schools. The mailings provide the principals and counselors with literature on engineering and include a form which can be used to request guidance assistance from the ECPD State Committees. Information on engineering is also sent to the directors of Summer Institutes sponsored by the National Science Foundation for mathematics and science teachers and by the U. S. Office of Education for counselors. Last summer, 485 Institutes having an estimated enrollment of 16,000 teachers and 3800 counselors were reached in this manner. Each Institute director was offered the assistance of the local ECPD Guidance Committee in arranging sessions devoted to engineering. The National Guidance Committee also keeps ECPD guidance pamphlets under review, makes revisions as necessary, and introduces new items for the use of the State Committees.

Further expansion of guidance programs is limited only by the number of engineers interested in helping. Thousands of engineers are already giving unstintingly of their time to this activity. The help of still more engineers is needed. ASME members who are able to help in this important engineering work should first check to see what their Section may already be doing in this field. Many Sections carry out special projects in co-operation with the program of their State ECPD Guidance Committee. Some engineers may prefer to volunteer their services as a speaker directly to the ECPD chairman for their Region. A roster of the ECPD State Chairmen is as follows:

Region I. R. H. Stockard, Director of Placement, University of Rhode Island, Kingston, R. I.

Region II. H. F. Roemmele, Placement Officer and Director of Alumni Relations, The Cooper Union, New York 3, N. Y.

Region III. D. M. Seeley, Executive Assistant—Engineering, U. S. Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.

Region IV. John C. Reed, Head, Department of Mechanical Engineering, University of Florida, Gainesville, Fla.

Region V. G. P. O'Connell, Assistant Manager, Educational Relations, General Motors Corp., 3044 W. Grand Blvd., Detroit 2, Mich.

Region VI. A. B. Drought, Dean, Engineering Department, Marquette University, 1515 W. Wisconsin Ave., Milwaukee 3, Wis.

Region VII. Robert Matteson, California Research Corp., Box 1627, Richmond, Calif.

Region VIII. J. G. McGuire, Assistant Dean, School of Engineering, Texas A&M College, College Station, Texas

Canada. Roger Lessard, Ecole Polytechnique, Montreal, Que.

Alaska. Prof. Charles Sargent, Dean of Faculty, University of Alaska, University, Alaska

Hawaii. Prof. B. M. Harloe, College of Engineering, University of Hawaii, Honolulu 14, Hawaii

EJC Assembly Evaluates Engineers and Problems They Will Have to Face in Future

The Engineers Joint Council (EJC) held its annual meeting Jan 19, 1961, at the Hotel Biltmore in New York, N. Y.

A complete report of the developments that took place at this meeting will appear in the Winter Edition of EJC's newspaper, *Engineer*, soon to be mailed to all members of the Founder Societies (of which ASME is one). Briefly, the Board of Directors met in open session in the morning, and the General Assembly met in the afternoon. New officers were installed. The new president, J. M. Landis, vice-president of Bechtel Corporation, San Francisco, Calif., is a Past-President of ASME.

Luncheon speaker was Colonel D. O. Omer, Deputy Director of Selective Service, who gave a clear and altogether encouraging report on the Service's

policy on the drafting of young engineers and scientists. Selective Service is just as eager as anybody else to keep such young men where they can best serve the country. But there must never be the slightest justification for the notion that the rich—by sending their sons through engineering schools—can, in effect, purchase their deferment. It is a nice problem in public policy and public need. Colonel Omer urged that all engineering firms maintain detailed reports on the duties of all their young engineers, so that in the event of national emergency the draft boards can have immediate, reliable information on which to act.

At the banquet, the main speaker was Dr. D. W. Bronk, Hon. Mem. ASME, and president of the National Academy of Sciences, who made an observation that delighted many of the engineers present. He said: "Who is a scientist? Who is an engineer? I've always been puzzled that there is a difference. An engineer is a scientist who is more than a scientist. . . .Science is merely knowledge. Engineering puts that knowledge to work."

During the afternoon session, President Landis had occasion to speak on unity among the engineering societies. The integration of the work of the societies is one of the prime functions of EJC. Mr. Landis reported that the work toward unity is progressing handsomely. He said, "Actually, I am astonished at the amount of unity we already have. And it will get better." (See article on unity, pp. 30–33, this issue.)

PEOPLE

In **left photo** Secretary of the Navy William B. Franke, left, pins the Distinguished Service Medal, the Navy's highest peacetime award, on Vice-Admiral H. G. Rickover for his pioneer work in the Navy's nuclear-powered submarine program. The ceremonies, on January 17, were held at General Dynamics Corporation's Electric Boat Division, Groton, Conn. The dockside ceremonies aboard the **USS Nautilus** commemorated the sixth anniversary of the submarine's maiden voyage on nuclear power. **Right photo,** before the award ceremony, one sees French Ambassador Harve Alphand print "nuclear initials" on the keel plate of the Navy's newest Polaris missile-firing submarine, **Lafayette.** The 7000-ton submarine is named after the Marquis de Lafayette who played an important role in aiding the Colonies during the American Revolution. Ambassador Alphand uses a welding torch supplied with power from the nuclear reactor of the **USS Nautilus** anchored in a nearby slip. Flanking Ambassador Alphand at the keel-laying ceremonies are, left to right, the welder, Secretary of the Navy Franke, and Vice-Admiral Rickover. In 1955 Vice-Admiral Rickover was the recipient of the ASME George Westinghouse Gold Medal.

Honors and Awards. Isidor B. Laskowitz, Mem. ASME, of the Laskowitz Helicopter Company, Inc., Brooklyn, N. Y., has received the D. B. Steinmen Award from the New York Academy of Sciences for an original paper in the field of aviation research. His paper, entitled "Vertical Take-Off and Landing Rotorless Aircraft With Inherent Stability," describes a new concept for simple, high-speed, stable, vertical take-off and landing aircraft without rotors.

Sir John Cockcroft, British physicist and Nobel Prize winner, was named to receive the 1961 Atoms for Peace Award. The prize consists of $75,000 and a gold medallion. It will be presented April 6 at M.I.T. The Atoms for Peace Awards were established as a memorial to Henry and Edsel Ford and are financed through a grant of $1 million from the Ford Motor Company Fund.

Theodore von Karman, Mem. ASME, recently received the honorary degree of doctor of science at Brown University. Dr. von Karman created, and for a decade served as chairman of, the NATO Advisory Group for Aeronautical Research and Development. The Society honored him in 1941 with the ASME Medal. In 1958, he received the Timoshenko Medal.

Among the 15 scientists named as U. S. "Men of the Year" by *Time* magazine in its January 2 issue, was Charles Stark Draper, Fellow ASME, of the Massachusetts Institute of Technology. He is the aeronautical engineer largely responsible for the development of the inertial guidance systems that control far-ranging U. S. missiles, including the Polaris.

Harold B. Maynard, Fellow ASME, president of Maynard Research Council, Inc., Pittsburgh, Pa., has been paid

For the first time in Canadian history, engineers hold the chancellorships of four Canadian universities. Honored at a luncheon in Montreal in December, they are, **left to right,** J. B. Stirling, Queen's University; R. E. Powell, McGill University; C. J. MacKenzie, Carleton University; and The Right Honorable C. D. Howe, Hon. Mem. ASME, Dalhousie University. Dr. Howe passed away Dec. 31, 1960, quite suddenly of a heart attack at his home in Montreal.

Hueston M. Smith, **left,** president of the Consulting Engineers Council, talks with J. C. Warner, president of Carnegie Institute of Technology, guest of honor and featured speaker at the semiannual meeting of the CEC board of directors in Pittsburgh, Pa., recently. Dr. Warner reminded the consultants of their moral obligation to prevent the squandering of the nation's scientific and engineering manpower as government-sponsored research would absorb "at least half of the new PhD's in physics and engineering produced in the next decade."

highest industrial management honors by McGraw-Hill Book Company, who selected him to be editor-in-chief of the first "Top Management Handbook," which was published in November, 1960. Featured in the 1248-page book as authors of one chapter each are top businessmen selected as representatives of a broad cross section of American thinking in management.

T. KEITH GLENNAN, president-on-leave from Case Institute of Technology, has been nominated for the 1961 meritorious service award of the National Society of Professional Engineers in recognition for his outstanding performance in the field of engineering education, and for pioneering leadership as the first administrator of NASA.

The National Association of Corrosion Engineers, at its 17th annual conference in Buffalo, N. Y., March 13–17, will bestow its Willis Rodney Whitney Award on H. R. COPSON, International Nickel Company Research Laboratory, Bayonne, N. J.; and its Frank Newman Speller Award on KENNETH G. COMPTON, Bell Telephone Laboratories, Inc., Murray Hill, N. J. The awards are given for public contributions to the science of corrosion and corrosion engineering.

HAROLD S. OSBORNE of Upper Montclair, N. J., retired chief engineer of the American Telephone and Telegraph Company, has won the Edison Medal of the American Institute of Electrical Engineers. Cited for his contributions to telecommunication and his achievements in co-ordinating international communication and in national and international standardization, he received the award at the institute's winter general meeting, January 29–February 3, at the Hotel Statler, New York, N. Y.

Establish O. W. Boston Research Fund. At the suggestion of Research Prof. A. O. SCHMIDT, funds accumulating in his name at Marquette University College of Engineering have been used to establish the O. W. Boston Research Fund for Advancement in the Fields of Metal Processing. Professor Boston, Fellow ASME, who lives in Ann Arbor, Mich., retired two years ago as professor and chairman of the department of metal processing at the University of Michigan. He has published about 100 research papers in his field and has trained many engineers to continue progress in the metalworking field. In 1950, ASME awarded him the Worcester Reed Warner Medal and, in 1956, honored him again by conferring the Blackall Machine Tool and Gage Award.

New Officers. MERRILL A. SCHEIL, Mem. ASME, has taken office as the national secretary of the American Society for Metals, a post he will hold for two years.

WILLIS F. THOMPSON, Fellow ASME, and executive vice-president of Westcott and Mapes, Inc., New Haven, Conn., has been elected president of the United Engineering Trustees, Inc.

RALPH F. GOW, Mem. ASME, has become president of Norton Company, the largest abrasive manufacturer in the world, which operates 25 plants in the U. S., Canada, and overseas. He was elected at the company's 76th annual

Members from Louisiana who got together at an ASME luncheon during the Louisiana Engineering Society's annual meeting in Baton Rouge, January 12–13, are, **left to right,** Grover Trammell, ASME Monroe Group chairman; Allen H. Jensen, Vice-President, ASME Region X; G. J. Groh, New Orleans Section chairman; and E. S. Adler, Jr., chairman of the ASME Baton Rouge Subsection.

Explorer Scout Robert Dubosy of Seaford, N. Y., packs technical publications donated by Sperry Gyroscope Company for use in engineering colleges in slowly developing countries. Some 20 scouts, all members of two Explorer Scout troops sponsored by Sperry for its employees' sons, teamed up to ship more than three tons of magazines regularly collected by the company at its facility, 3602 Northern Boulevard, Long Island City, N. Y. Other engineers employed on the East Coast also contribute publications to the Sperry project, which is part of the U. S.'s "People to People" cultural exchange program instituted in 1956.

H. W. Ritchey, **right,** newly elected president of the American Rocket Society (an affiliate of ASME) for 1961 and vice-president of Thiokol Chemical Corporation, congratulates three Air Force officers who won the annual ARS-Thiokol Graduate Student Award. Winners of the award for their joint effort on a scientific paper on the ion rocket engine are, **left to right,** First Lieutenant Charles A. Huebrer, Dearborn, Mich.; Captain James M. Glassmeyer, Cincinnati, Ohio; and Captain Richard J. Hayes, Medford, Mass. The award, a check for $1000, was presented at the society's annual convention in Washington, D. C., December 7.

meeting, January 17. George N. Jeppson, Mem. ASME, remains on the board with the title of honorary chairman.

Bristow Guy Ballard, vice-president (scientific) of the National Research Council, has been elected president of The Engineering Institute of Canada for 1961–1962. Dr. Ballard, who was awarded the Order of the British Empire for distinguished scientific contributions during the second world war, will assume office during the 75th annual EIC meeting in Vancouver, May 31–June 2, 1961.

Henry Balfour, art editor, ASME, and Assoc. Mem. ASME, has been elected national president of the Society of Business Publication Designers.

Murray A. Wilson, consulting engineer, Wilson and Company, Salina, Kan., has been nominated for the presidency of the National Society of Professional Engineers.

Robert F. Moody, general sales manager, Hyster Company, Portland, Ore., has been elected president of The Material Handling Institute.

Appointments. Frank L. Schwartz, Mem. ASME, has been named director of engineering for Lauson Power Products Division of Tecumseh Products Corp. in Michigan. He is a former professor of mechanical engineering at the University of Michigan and consultant to the Atomic Energy Commission.

Hans Ernst, Fellow ASME, University of Cincinnati, has been on a U. S. Government assignment to Israel during January and February. Acting as an industrial adviser in metal processing, Professor Ernst has been headquartered in Haifa under contract with the International Cooperation Administration, Washington, D. C.

Christmas cheer for needy families in the form of canned goods and money was collected in a joint drive by the ASME Oregon Section and the Sunshine Division of the Portland Police Department. Part of the store is displayed by Russell Reese, **right,** Assoc. Mem. ASME, chairman of the Oregon Section, and Captain Hugh Davenport of the Sunshine Division. The December Section meeting was devoted to the drive, and featured James McCanna, Assoc. Mem. ASME, speaking on nuclear power development.

Campus Data. Charles L. Tutt, Jr., Mem. ASME, has been named to the newly created post of Dean of Engineering at General Motors Institute.

Myron Tribus, Mem. ASME, professor of engineering at the University of California, Los Angeles, has been appointed dean of Dartmouth College's Thayer School of Engineering. He will take the post in the fall. In World War II when with the Air Force, he developed thermal ice-protection equipment for aircraft. For this, Dr. Tribus received the Thurman H. Bane Award from the Institute of Aero-Space Sciences and the Wright Brothers' Medal from the Society of Automotive Engineers.

George Gerard, Mem. ASME, associate director of the Research Division of New York University's College of Engineering, has been appointed staff director for the academic and research development of NYU's University Valley at Sterling Forest, New York. It is a 1000-acre tract in Orange County for which a scientific and educational community is planned.

Donald R. Jenkins, Mem. ASME, has been named an associate professor of mechanical engineering at Lafayette College effective September 1. He is now an assistant professor.

Richard Franklin Humphreys has been appointed president of The Cooper Union for the Advancement of Science and Art in New York City. A leading scientist in the nuclear field, Dr. Humphreys is now vice-president of Armour Research Foundation of the Illinois Institute of Technology.

National Engineers' Week. Among 14 leading engineering figures from industry, education, government, and private practice who served as individual sponsors for the 1961 National Engineers' Week, February 19–25, are included Clarence H. Linder, Mem. ASME, vice-president, General Electric Company; R. H. Roy, Fellow ASME, dean of the school of engineering at The Johns Hopkins University; and Raymond R. Tucker, Mem. ASME, Mayor of St. Louis.

Sol Domeshek, Assoc. Mem. ASME, head of the Visual Systems Branch at the U. S. Naval Training Device Center, Port Washington, N. Y., recently received his eleventh patent award—this one for the development of a stereo ranging attachment for a large transparency projector. The award has been offered to the Government on a royalty-free basis.

ASME Arranges Lecture Tour for Dr. Bishop, Vibrations Specialist

One of England's leading young engineers, Prof. R. E. D. Bishop, will address groups of educators, engineers, and students at 15 colleges and universities in the United States during March and April under a program arranged by The American Society of Mechanical Engineers. The lecture program, organized by the ASME National Committee of Mechanical Engineering Department Heads, was made possible by a grant of the National Science Foundation to Engineers Joint Council.

Dr. Bishop, the visiting lecturer, is Kennedy Professor of Mechanical Engineering and head of the department at University College, London. His specialty is the field of vibrations. His talks, to be delivered at colleges and universities, are open to all interested

Professor R. E. D. Bishop

persons. Topics will range from a nontechnical outline of engineering vibration problems intended for the interested layman to a discussion of the theory of resonance testing and of the vibration of rotating shafts "which will probably be understandable only to graduate students." Other talks are intended for intermediate groups.

Dr. Bishop's lecture schedule follows.

School	Date
Drexel Institute of Technology	March 3
Catholic University of America	March 6–7
University of Virginia	March 8
North Carolina State College	March 9–10
Georgia Institute of Technology	March 13
University of Texas	March 16
California Institute of Technology	March 20
University of California (Berkeley)	March 22–24
University of Colorado (Boulder)	March 27
Illinois Institute of Technology	March 30
Case Institute of Technology	March 31
Syracuse University	April 3
Rensselaer Polytechnic Institute	April 4–5
Yale University	April 6–7
New York University	April 10–11

Dr. Bishop's professional work lies in mechanical and aeronautical engineering. This has involved consulting work for a number of years and has largely been concerned with problems of mechanical vibration and stress analysis. He is part author (with Prof. D. C. Johnson) of the book entitled "The Mechanics of Vibration" (Cambridge, 1960). Recent work has been largely on the vibration of rotating shafts, the uses of matrix analysis in vibration, and the theory of resonance testing.

International Heat Transfer Conference Plans to Review Newest Applications and Research Developments

PLANS for a five-day International Heat Transfer Conference, Aug. 28 to Sept. 1, 1961, at Boulder, Colo., have progressed so satisfactorily that the advance program will be available early in April, according to A.C. Mueller, Chairman of the Joint Committee on North American Participation.

The conference, sponsored by four engineering societies, two American (including ASME) and two British, with participation by eight others, will be held on the campus of the University of Colorado. Papers will be presented by engineers from the United States, Canada, England, USSR, Japan, Poland, Australia, France, Switzerland, Scotland, Sweden, Germany, and Yugoslavia.

Dr. Mueller also noted that more than 100 papers on recent original work and new applications in heat-transfer theory and practice will be reviewed by reporters and discussion of the papers will be emphasized. All engineers and scientists are urged to attend and participate in the discussion.

In addition, four lectures will review and synthesize recent developments in research and application. According to S. P. Kezios, Secretary of the Committee on North American Participation, discussion at the Boulder Conference will be continued at a special meeting in London, England, in 1962 under the auspices of The Institution of Mechanical Engineers.

Registration information and advance programs may be obtained by writing to The American Society of Mechanical Engineers, Meetings Department, 29 West 39th Street, New York 18, N. Y. Advance registrants at the Boulder Conference will receive a bound copy of all papers before the meeting. Copies of the proceedings, including discussion at both the Boulder Conference and the London meeting, will be available in 1962.

A special feature of the conference will be talks by four visiting lecturers during the week. Lecturers and their topics are: Prof. E. R. G. Eckert of the University of Minnesota, "Heat Transfer Under Forced Convection Conditions"; Prof. H. C. Hottel of Massachusetts Institute of Technology, "Gaseous Radiation"; Prof. O. A. Saunders of Imperial College, London, England, "Progress of Engineering Calculation of Heat Transfer"; and Prof. Ernest Schmidt of The School for Technical Thermodynamics, Munich, Germany, "Heat Transfer Under Natural Convection Conditions."

Britain is represented by The Institution of Mechanical Engineers and the Institution of Chemical Engineers. Sponsors and cohosts of the conference in the United States are The American Society of Mechanical Engineers and American Institute of Chemical Engineers. Also participating are the American Chemical Society, the American Nuclear Society, the American Rocket Society, the American Refrigerating and Air Conditioning Engineers, Chemical Institute of Canada, The Engineering Institute of Canada, the Institute of Aerospace Sciences, the Society of Automotive Engineers, and the University of Colorado.

The first International Heat Transfer Conference was held in London, England, in 1951.

MEETINGS OF OTHER SOCIETIES

• IN THE UNITED STATES

March 20–22

SAE, national production meeting, Netherland Hilton Hotel, Cincinnati, Ohio.

March 20–23

IRE, national convention, Waldorf Astoria Hotel and Coliseum, New York, N. Y.

March 20–23

Instrument Society of America, instrument-automation conference, Armory, Washington, D. C.

March 20–24

ASM, 12th Western metal congress and exposition, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.

March 27–31

Symposium on "Temperature, its Measurement and Control in Science and Industry," sponsored by the American Institute of Physics, Instrument Society of America, and National Bureau of Standards, Columbus, Ohio.

April 4–5

SPE, Plastics Injection Molding Workshop, Holy Cross College, Worcester, Mass.

April 4–7

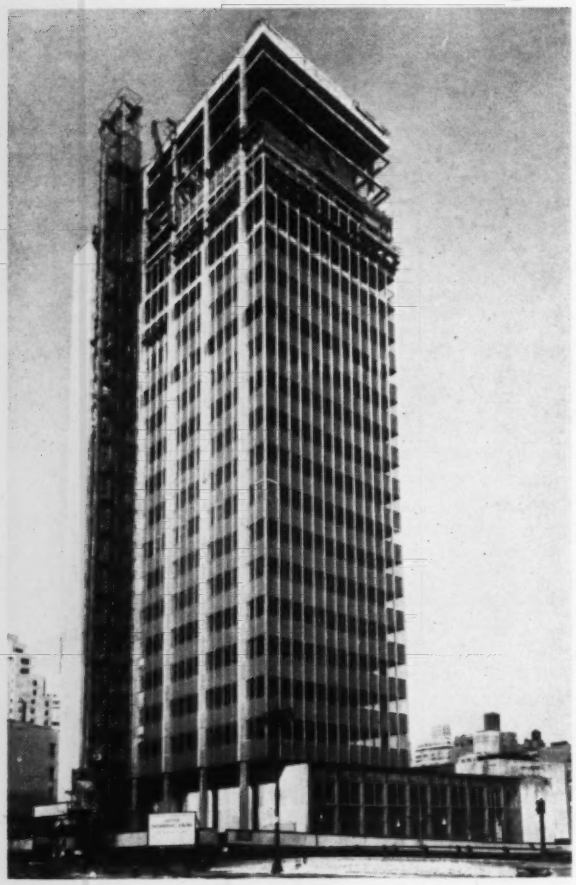
SAE, national aeronautic meeting, production forum, and engineering display, Commodore Hotel, New York, N. Y.

April 5–7

Institute of Environmental Sciences, technical

United Engineering Center

Every Member's Responsibility



On February 1 this is how the United Engineering Center looked

To DATE, two out of every three ASME members have not contributed to the Center. We appeal directly to you to send your subscription now to your Section Chairman; checks should be made payable to: United Engineering Trustees, Inc.

To those of you who have contributed, review your position and join those of us who have made two and sometimes three subscriptions. ASME needs the active material support of every member, to the fullest extent of his means.

As this goes to press we need a substantial sum to meet our quota. In 13 of the past 18 weeks ASME has led the way in contributions received; this is a tribute to the concerted effort being made in many sections to achieve 100 per cent plus of quota. Fairfield, Conn., Section went over the top with a rush in December, adding 28.4 per cent to an already commendable achievement. Anthracite Lehigh joined the 100 per cent club as did Sabine, and Erie missed by a whisker. It is encouraging to note steady progress in such areas as Boston, Greenville, Kansas City, and St. Louis. Cleveland, Pittsburgh, and Milwaukee are all close to quota; that last lap kick should do the job. Our success in this venture depends on teamwork and imagination in every Section no matter how large or how small.

Moving day is approaching rapidly, we want a debt-free home when we occupy our new quarters. Is your Section doing its part? Have you done yours?

program and equipment exposition on global and space environments, Sheraton Park Hotel, Washington, D. C.

April 5–7

AIEE, southeast meeting, Jung Hotel, New Orleans, La.

April 10–11

Society of Naval Architects and Marine Engineers, spring meeting, San Francisco, Calif.

April 10–12

AIME, 44th national open hearth and blast furnace, coke oven and raw materials conference, Sheraton Hotel, Philadelphia, Pa.

April 10–14

American Society of Civil Engineers, convention, Hotel Westward Ho, Phoenix, Ariz.

April 10–21

American Welding Society, 42nd annual convention, Commodore Hotel, New York, N. Y., and welding show, April 18–20, New York Coliseum. AWS also will act as host to the International Institute of Welding, which is holding its annual assembly April 10–15, Sheraton-Atlantic Hotel, New York.

April 12–14

AIME, joint international symposium on agglomeration, Sheraton Hotel, Philadelphia, Pa.

• IN EUROPE

April 17–19

International Meeting on Fluid Sealing, sponsored by the British Hydromechanics Research Association, Grosvenor Hall, Ashford, Kent, England.

May 2–9

Sixth international packaging exhibition, organized by N. V. 't Raedthuys, to be held in the R. A. I. exhibition halls, Amsterdam, The Netherlands.

May 15–19

The Institute of Fuel, conference on waste heat recovery from industrial furnaces, Bournemouth, England.

June 20–24

Fourth International Powder Metallurgy Congress, Reutte, Tyrol, Austria.

June 26–July 1

Second International Measurement Conference (IMEKO), Engineering Societies Building, and separately organized international measurement conference, Budapest, Hungary.

July 30–August 6

International Symposium on the Durability of Concrete, prepared by the Czechoslovak Academy of Sciences, Institute of Theoretical and Applied Mechanics, within the framework of The Permanent Committee of Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions (RILEM); to be held in Prague.

August 21–31

United Nations Conference on New Sources of Energy; and an industrial-commercial exhibition of equipment showing developments in solar, wind, and geothermal energy fields, organized by Rassegna Internazionale Elettronica, both in Rome, Italy.

• IN CANADA

October 19–November 7

The Iron and Steel Institute, special meeting in the U. S. and Canada.

(For ASME Coming Events, see page 108.)

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

Designing for the Competitive Market Theme of 1961 ASME Design Engineering Conference and Concurrent Design Engineering Show

- Four-day conference and show at Detroit's new Cobo Hall, May 22–25
- Automotive industry's approach to competition to be aired at opening panel
- 22 design papers to be presented in expanded technical program

COMPLETION of Cobo Hall makes it possible for the first time to present the ASME Design Engineering Conference and the concurrent Design Engineering Show in Detroit, Mich., from May 22 through May 25, 1961.

The conference, sponsored by the ASME Machine Design Division, and the show, produced by Clapp and Poliak, Inc., New York exposition firm, have in the past attracted such large audiences, 2000 and 20,000, respectively, that it was not feasible to take this combined presentation of major importance into Detroit. However, with the modern, spacious, and convenient facilities made available by the recently completed Cobo Hall, 1961 will mark the first venture of this twin bill into the capitol of the automotive industry.

The Conference. "Designing for the Competitive Market," the theme of the conference, significantly points to the basic responsibility which faces the design engineer. The conference is designed to offer solutions to problems encountered in the field, or to suggest new approach to persistent problems.

To keynote the conference, on Monday morning four leading engineers from the automotive industry's capitol will participate in a panel discussion on the theme. They are Will Scott of Ford; H. M. Bevans of Chrysler; Conrad Orloff of Chevrolet; and Carl E. Burke of American Motors. They will tell how a car is engineered to meet marketing, cost, and quality considerations; how to design for maximum sales value per unit of cost; and how production engineering and design must be co-ordinated for most economical manufacture.

During the next three days, the 22 technical papers to be presented cover ways in which the engineer can plan and design better quality products and lower manufacturing costs; standardization of design materials and drawing techniques;

All roads lead to Cobo Hall. At the western elevation of Cobo Hall, the John C. Lodge Expressway terminates with ramps leading to principal downtown streets and to the spiral ramp for Cobo Hall's 1150-space roof parking site. By taking the Larned Street ramp, the motorist finds access to another 1018 parking spaces within the basement or underground garage serving the gigantic exposition hall.

metals and nonmetallics; glass and ceramics; and others, to give a comprehensive description of the latest changes and innovations occurring in the field.

It has been said that "until design engineering has done its work, purchasing has nothing to buy, production has nothing to manufacture, sales has nothing to sell." Although this is true, the essential and basic role of design engineering is at no other time so fully appreciated as when competition is acute, and every company's success depends upon its ability to design superior products that can be sold at lowest possible cost.

As is the custom, the technical sessions will be held in the morning so that there will be ample time to go through the show, which is open in the afternoon. The way to get the most benefit from the show is to see it thoroughly . . . this takes time, and if possible should be seen more than once. There is so much to see, something of importance might easily be missed.

The Show. The Design Engineering Show this year is the biggest and most diverse. The utmost of careful planning has gone into its production.

During the show, in 1960, held in the New York Coliseum, exhibitors met to choose their space for the 1961 show. It got a little busy one morning, more than 90 per cent of the available space in this new huge Cobo Hall was contracted for, and shortly thereafter the remainder of space was spoken for.

Four hundred exhibitors—who have been planning for a year—will display the latest, newest in materials, components, and other original equipment to see and compare. There also will be shown redesigned items, with the kinks ironed out.

At the show, to derive the most compensation (for tired feet and worn-out eyes), discuss your problems with the exhibitors; many are qualified applications engineers and are more than willing to be helpful and to offer suggestions to help solve your design problems.

The show is one of the largest industrial expositions in the country. It is devoted to the research and development of new products, and it will occupy five acres of exhibit area.

ASME Metals Engineering Conference in Pittsburgh Keynoted by Theme—"Tailoring Metals to Engineering Design Requirements"

The Penn-Sheraton, in The Heart of the Golden Triangle, Pittsburgh, Pa., will serve as Headquarters for the ASME Metals Engineering Conference, April 23–25, 1961. Three sessions and one panel discussion will comprise the two-day program whose theme is "Tailoring Metals to Engineering Design Requirements." High lights of the social program will be two luncheons, one featuring a talk by Dr. Patrick Lang on "The Use of Metal Implants in Surgery," and the other a talk by William H. Byrne, President of the ASME.

▶MONDAY, APRIL 24

Session 1 **9:30 a.m.**

Materials and Atomic Energy,[1] by *D. A. Douglas, Jr.*, Union Carbide Nuclear Co., Oak Ridge, Tenn.

Materials and the Space Program,[1] by *Warren Eding*, National Academy of Sciences, Washington, D. C.

Materials for Power Conversion,[1] by *J. C. R. Kelly, Jr.*, Westinghouse Electric Corp., Pittsburgh, Pa.

Session 2 **2:30 p.m.**

Energy Criterion for Low-Cycle Fatigue,[1] by *D. E. Martin*

An Analysis of the Time and Temperature Dependence of the Upper Yield Point in Iron, by *P. E. Bennett* and *G. M. Sinclair*, Univ. of Illinois, Urbana, Ill. (Paper No. 61—Met-1)

Dynamic Elastic Modulus Values at Room and Elevated Temperatures of Some Materials for Missile Application,[1] by *H. W. Wyatt*, AVCO Mfg. Corp., Wilmington, Mass.

[1] Paper not available—see box on this page.

Heart of the Golden Triangle in Pittsburgh, Pa., does it look familiar? It will be more so, for the Penn-Sheraton Hotel is situated here and from April 23–26 will be headquarters for the ASME 1961 Metals Engineering Conference. The theme: "Tailoring Metals to Engineering Design Requirements," should bring out a large, interested audience.

Availability of Papers

Only numbered ASME papers in this program are available in separate copy form until Feb. 1, 1962. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N. Y.** Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of Mechanical Engineering containing an account of the Conference.

▶TUESDAY, APRIL 25

Session 3 **9:30 a.m.**

Effects of Interrupted Quench Procedures on the Properties of Type 410 Stainless Steel,[1] by *J. Bressanelli* and *J. Hoke*

Effect of Specimen Size and Notch Acuity on the Brittle Fracture Strength of a Heat-Treated Steel, by *S. Yukawa*, General Electric Co., Schenectady, N. Y.; and *J. G. McMullin*, Crucible Steel Co., Pittsburgh, Pa. (Paper No. 61—Met-2)

Elastic and Creep Characteristics of a Class of Shell Closures With Constant Stress Ratio, by *A. E. Gemma, G. H. Rowe*, and *R. J. Spahl*, Pratt & Whitney Aircraft Div., United Aircraft, Middletown, Conn. (Paper No. 61—Met-3)

[1] Paper not available—see box on page 106.

Session 4—Panel Discussion **2:30 p.m.**

Metals Research Now and in the Future

Paul W. Marshall, U. S. Steel Corp., Monroeville, Pa.

F. M. Richmond, Universal-Cyclops Steel Corp., Bridgeville, Pa.

C. L. Brooks, Reynolds Metals Co., Richmond, Va.

J. T. Eash, International Nickel Co., Inc., Bayonne, N. J.

Improving the Techniques of Managing for Profit—SAM-ASME Management Conference Subject

THE steady erosion of profits by constantly rising costs can only be overcome by improving management technology. The sixteenth annual SAM-ASME Management Engineering Conference to be held April 6–7, 1961, at the Statler Hilton Hotel in New York City, is designed to help management achieve this aim.

Many new practical ideas and applications which have demonstrated their usefulness in many companies will be discussed in talks and technique-oriented workshops. Only the live impact of a conference can provide the stimulus necessary to crystallize imaginative ideas into a specific application for a company. Key personnel, through attendance at this conference, can readily obtain ideas from first-hand expert sources and be stimulated to apply them.

▶THURSDAY, APRIL 6

Cost Reduction and Profit Improvement **9:15 a.m.**

The Effective Approach to Cost Reduction, by *A. J. Piacquad*, Curtiss-Wright Corp., Wood-Ridge, N. J.

Cost Reduction Through a Methods-Engineering Team, by *D. J. McIntosh*, McKinnon Industries, Ltd., St. Catharines, Ont., Canada

Integrated Data Processing **9:15 a.m.**

Practical Design of Data Processing Systems in the '60's, by *John Diebold*, John Diebold Associates, New York, N. Y.

Management Information Systems, by *M. M. Stone*, Arthur D. Little, Inc., Cambridge, Mass.

Work Measurement and Wage Incentives **2:30 p.m.**

Measurement of Organizational Effectiveness by *W. J. Fuhro*, Ordnance Corps, Raritan Arsenal, Metuchen, N. J.

Wage Incentives—Where Are They Headed?, by *Robert Rice, Factory Magazine*, McGraw Hill Publishing Co., New York, N. Y.

Applied Operations Research **2:30 p.m.**

A Case History on Job-Shop Simulation, by *W. E. Barnes*, General Electric Co., Schenectady, N. Y.

Practical Theory on the Use of Statistics, by *J. M. Allderige*, Cornell Univ., Ithaca, N. Y.

Workshops

Marketing Management Simulation	a.m. and p.m.
Linear Programming	a.m. and p.m.
Finding Profit Leaks	a.m.
Work Sampling	p.m.

▶FRIDAY, APRIL 7

New Developments in Materials Management **9:15 a.m.**

Planned Materials Procurement, by *W. E. Welch*, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Materials Distribution, by *G. W. Van Schaick*, American Cyanamid Co., New York, N. Y.

New Approaches to Production Planning and Control **9:15 a.m.**

Computerized Control of Quality, by *J. R. Wilson*, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

An Application of Probability Theory to Process Scheduling, by *Alan Gast*, Procter & Gamble, Cincinnati, Ohio

Motivation—Key to Productivity **2:30 p.m.**

Creative Leadership by Management, by *F. F. Bradshaw*, management consultant, Croton-on-Hudson, N. Y.

Stimulating Employee Will to Work, by *Ray Katzell*, New York Univ., New York, N. Y.

Extreme Temperature Lubrication to Be Discussed at Upcoming ASME Lubrication Symposium

THE Lubrication Division of The American Society of Mechanical Engineers will conduct a three-day symposium on "Extreme Temperature Lubrication" at the Deauville Hotel in Miami, Fla., May 8–10, 1961.

This symposium is the fourth in an annual series, and is planned to furnish a forum for the discussion of specific problem areas in the field of lubrication.

Papers will be presented on liquid metals lubrication, lubrication of high-speed ball bearings at 1200 F, selection of lubrications for high-temperature, frictional behavior of refractory materials at high temperatures, lubrication at cryogenic temperatures, gas-lubricated bearings, and many others of importance to all technical people concerned with extreme temperature lubrication problems.

Specialists in their field have been invited to participate, and for those who have an interest in Extreme Temperature Lubrication, it is recommended that plans be made now to attend this conference.

One inviting aspect of this meeting is the location and facilities where the conference will take place. An excellent social program is planned, and a refreshing dip in the Atlantic during lunch hour is something that one may look forward to. Also, events have been planned for the women, and an enjoyable as well as educational time should be in prospect.

1961 ASME-AIEE Railroad Conference

THIS Railroad Conference planned for April 20 and 21 in San Francisco, Calif., has been canceled.

▶MONDAY, MAY 8

Session 1 Hydrodynamic Lubrication **9:00 a.m.**

Nonrotating Journal Bearings Under Sinusoidal Loads, by *R. M. Phelan*, Cornell Univ., Ithaca, N. Y. (Paper No. 61—Lubs-6)

Squeeze Films: A Finite Journal Bearing With a Fluctuating Load,[1] by *D. F. Hays*, General Motors Corp., Warren, Mich.

Journal Bearings With Arbitrary Position of Source, by *J. V. Fedor*, U. S. Naval Lab., Silver Springs, Md. (Paper No. 61—Lubs-2)

A Solution of Reynolds Equation for a Full Finite Journal Bearing, by *S. Ramachandra*, Central Mining Research Station, Bihar, India. (Paper No. 61—Lubs-1)

Session 2 Gas-Lubricated Bearings **2:00 p.m.**

Externally Pressurized Step Bearings,[1] by *C. R. Adams, J. Dworski*, and *E. M. Shoemaker*, Boeing Airplane Co., Seattle, Wash.

Analytical and Experimental Study of Externally Pressurized Air Lubrication Journal Bearings,[1] by *J. R. Lemon*, Cincinnati Milling Machine Co., Cincinnati, Ohio

Externally Pressurized Gas Bearings for Navigation Instruments, by *H. C. Rothe*, ABMA, Huntsville, Ala. (Paper No. 61—Lubs-4)

Air Lubrication—A Development Tool,[1] by *M. L. Levene*, RCA, Camden, N. J.

▶TUESDAY, MAY 9

Session 3 Liquid Metals Lubrication **9:00 a.m.**

Liquid-Mercury Lubricated Hydrosphere Bearings,[1] by *G. Y. Ono* and *D. C. Reemsnyder*, Thompson Ramo Wooldridge, Inc., Cleveland, Ohio

[1] Paper not available—see box on page 108.

Availability of Papers by Mail

ONLY numbered ASME papers in this program are available in separate copy form until March 1, 1962. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, New York.** Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

An Apparatus for Investigating the Hydrodynamic Lubricating Behavior of Liquid Metals,[1] by *P. H. McDonald, Jr.*, and *E. D. Curley*, North Carolina State College, Raleigh, N. C.

An Analysis of a Finite Length Journal Bearing With Application to Liquid Metal Lubricants,[1] by *W. T. Snyder* and *L. N. Connor, Jr.*, North Carolina State College, Raleigh, N. C.

Frictional Behavior of Sodium Lubricated Materials in a Controlled High-Temperature Environment,[1] by *J. W. Kissel, W. A. Glaeser*, and *C. M. Allen*, Battelle Memorial Inst., Columbus, Ohio

Session 4 Rolling Elements Bearings 2:00 p.m.

The Lubrication of Ball Bearings With Solid Films,[1] by *M. J. Devine, E. R. Lamson*, and *J. H. Bowen, Jr.*, Aeronautical Materials Lab., Philadelphia, Pa.

Evaluation of Unconventional Lubricants at 1200 F in High-Speed Rolling Contact Bearings,[1] by *D. S. Wilson*, Fairchild Airplane and Engine Corp., Hagerstown, Md.

The Use of Free-Energy Relationships in the Selection of Lubricants for High-Temperature Applications,[1] by *F. K. Orcutt, H. H. Krause*, and *C. M. Allen*, Battelle Memorial Inst., Columbus, Ohio

Fluid Lubrication Theory of Roller Bearings,[1] by *Sasaki, Mori*, and *Okino*

▶WEDNESDAY, MAY 10

Session 5 Friction and Wear 9:00 a.m.

Boundary Lubrication of Copper, Mild Steel, and Stainless Steel During Severe Cold Deformation, by *P. R. Lancaster*, Inst. of Tech., Bradford, England; and *G. W. Rowe*, Univ. of Birmingham, Birmingham, England (Paper No. 61—Lubs-5)

Friction and Wear Behavior of Refractory Materials at High Sliding Velocities and Temperatures,[1] by *L. B. Sibley*, Battelle Memorial Inst., Columbus, Ohio

Boric Oxide as a High-Temperature Lubricant,[1] by *E. Rabinowicz* and *I. Imai*, M.I.T., Cambridge, Mass.

A Study of High-Temperature Oscillating Plain Bearings,[1] by *W. J. Zielenbach*, Battelle Memorial Inst., Columbus, Ohio

Session 6 Extreme Temperature Bearings 2:00 p.m.

Rolling Contact Fatigue Studies With Four Tool Steels and a Crystallized Glass Ceramic, by *E. V. Zaretsky* and *W. J. Anderson*, NASA, Lewis Research Center, Cleveland, Ohio (Paper No. 61—Lubs-3)

Once Through Lubrication Systems for High-Temperature Ball-Bearing Operation,[1] by *P. Lewis* and *S. F. Murray*, General Electric Co., Schenectady, N. Y.

Lubrication With Condensed Gases at Cryogenic Temperatures,[1] by *G. S. Reichenbach* and *D. E. Foraker*, Alloyd Corp., Cambridge, Mass.

Investigation of Ball Bearings Operating Submerged in Liquid Nitrogen,[1] by *J. A. Brennan, W. A. Wilson*, and *R. Radebaugh*, U. S. Department of Commerce, Boulder, Colo.

Designing With Materials and Processes for Extreme Temperature Lubrication,[1] by *G. W. Oliver*, San Diego, Calif.

Recent Advances in Steels for High-Temperature Bearings,[1] by *A. E. Nehrenberg, G. Steven*, and *T. V. Philip*, Crucible Steel Co. of America, Pittsburgh, Pa.

Additional Papers to be Presented

A Cryogenic Bearing,[1] by *D. F. Wilcock*, General Electric Co., Pittsfield, Mass.

Radioactive Techniques as Applied to Studying Bearing Performance,[1] by *T. Tallian* and *J. C. Lawrence*, SKF Industries, Philadelphia, Pa.

High-Temperature Bearing Lubrication,[1] by *A. S. Irwin*, Marlin-Rockwell Corp., Jamestown, N. Y.

[1] Paper not available—see box on this page.

Call for Manuscripts—Symposium on Thermophysical Properties, in Princeton, N. J., January, 1962

THE Second Symposium on Thermophysical Properties will be held Jan. 24–26, 1962, at Princeton, N. J. Papers are invited by Eric F. Lype, chairman of the organizing committee; abstracts will be accepted until May 1, 1961, final manuscripts until July 1, 1961.

The meeting, expected to attract some 300 participants and emphasizing participation from European nations, will be held under the auspices of the Heat Transfer Division of The American Society of Mechanical Engineers. Papers by authors from the United States, England, Germany, and France already are scheduled.

Papers to be presented at the Symposium will be published at the time of the meeting, in a separate volume. Proceedings of the first symposium, held at Purdue University in 1959, were published by ASME under the title "Thermodynamic and Transport Properties of Gases, Liquids and Solids."

Authors who would like to present papers are asked to request information from Dr. Eric F. Lype, Chairman, Committee on Thermophysical Properties, c/o Thompson Ramo Wooldridge, 23555 Euclid Avenue, Cleveland, Ohio.

Manuscripts must be written in English and must contain original information, although they may later be published in foreign journals. Four broad groups of acceptable papers have been established, dealing, respectively, with new theoretical work; new experimental work; reviews of current status of theory; experimental techniques and available data; and documentation methods.

An outline of thermal properties to be covered by these papers prepared by the committee is as follows:

Thermodynamic properties[1] and equation of state.

1 PVT data and compressibility.
2 Specific heats, enthalpy, entropy.
3 Joule-Thomson coefficient.
4 Phase equilibria of single and multicomponent systems.
5 Ionization equilibrium.

Molecular properties.[1]

1 Spectroscopic data, Debye temperatures.
2 Ionization potentials.
3 Collision cross sections.
4 Intermolecular potentials.

Transparent properties.[1]

1 Thermal conductivity and electrical conductivity.
2 Shear viscosity and bulk viscosity.
3 Regular diffusion and thermal diffusion.
4 Heat of transfer.

Radiation properties[1] (heat and sound).

1 Emissivity and absorptivity.
2 Sound absorption.

[1] These properties will cover the following substances:
A Gases, normal and ionized plasma.
B Liquids, Newtonian and non-Newtonian.
C Solids, crystalline and amorphous, alloys.
D Plastics, elastomers.

ASME COMING EVENTS

March 5–9, 1961
ASME Gas Turbine Power Conference and Exhibit, Shoreham Hotel, Washington, D. C.

March 12–15, 1961
ASME Aviation Conference, Statler Hilton Hotel, Los Angeles, Calif.

March 12–17, 1961
ASME Boiler and Pressure Vessel Committee Out-of-Town Meeting, jointly with The National Board of Boiler and Pressure Vessel Inspectors, Barringer Hotel, Charlotte, N. C.

March 16–17, 1961
ASME Textile Engineering Conference, Clemson College, Clemson, S. C.

April 6–7, 1961
ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York, N. Y.

April 9–13, 1961

ASME Oil and Gas Power Conference and Exhibit, Jung Hotel, New Orleans, La.

April 10–11, 1961

ASME Maintenance and Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

April 23–26, 1961

ASME Metals Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

May 7–10, 1961

ASME-EIC Hydraulic Conference, Queen Elizabeth Hotel, Montreal, Que., Canada

May 8–9, 1961

Lubrication Symposium, Deauville Hotel, Miami Beach, Fla.

May 10–12, 1961

ASME Production Engineering Conference, Royal York Hotel, Toronto, Ont., Canada

May 22–25, 1961

ASME Design Engineering Conference and Exhibit, Cobo Hall, Detroit, Mich.

June 11–14, 1961

ASME Summer Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.

June 14–16, 1961

ASME Applied Mechanics Conference, Illinois Institute of Technology, Chicago, Ill.

August 28–30, 1961

ASME West Coast Conference of Applied Mechanics, University of Washington, Seattle, Wash.

August 28–September 1, 1961

Second International Heat Transfer Conference, University of Colorado, Boulder, Colo.

September 14–15, 1961

ASME-AIEE Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

September 24–27, 1961

ASME-AIEE National Power Conference, St. Francis Hotel, San Francisco, Calif.

September 24–27, 1961

ASME Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

October 4–6, 1961

ASME Process Industries Conference, Shamrock Hilton Hotel, Houston, Texas

October 17–19, 1961

ASME-ASLE Lubrication Conference, Morrison Hotel, Chicago, Ill.

November 26–December 1, 1961

ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(*For Meetings of Other Societies, see page 103.*)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or Division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers, 50 cents; to ASME members, free. Also available on request is a "Schedule of Program Planning Dates for Meetings and Publication Deadline Dates." Ask for Form M&P 1315.

International Co-Operation for Productivity, Topic of Production Engineering Conference

PLANS are maturing for a truly international representation on panels and in the presentation of papers at the 1961 Production Engineering Conference.

The date of the Conference is May 10–12. It is being sponsored by the Production Engineering Division of The American Society of Mechanical Engineers, with the co-operation of the Ontario Section, ASME, The Institution of Production Engineers, and the Engineering Institute of Canada.

The theme of the Conference is "International Co-operation for Productivity." The panels will consider machine and tool programming data at one session, and unification of instruction media for production machines at another. Metals-cutting research will have a number of interesting papers for discussion. Other aspects of production engineering will have contributors with a diversity of interests from a number of countries. A group from England is expected to contribute a session on production-control methods.

An interesting departure from standard practice is the arrangement of holding morning sessions in the Royal York Hotel, which is headquarters for the Conference, and afternoon sessions at the Canadian National Industrial Production Show which will be in the Canadian National Exhibition Park in the City of Toronto. This show, a biennial affair, is an exhibit of the latest in metalworking, fabricating, and productive equipment, techniques, and materials.

The City of Toronto, in which this Conference will be held, has many features of interest.

▶WEDNESDAY, MAY 10

Session 1 **9:30 a.m.**

Production Engineering in an International Company,[1] by *H. A. Wallace*, Massey-Ferguson Ltd., Toronto, Ont., Canada

International Progress in the Planning and Design of Factories,[1] by *D. L. Nicolson*, Production-Engineering Ltd., London, England

International Productivity Co-Operation in the Future,[1] by *Walter Woodford*, Inst. of Production Engineers, United Kingdom

[1] Paper not available—see box on this page.

Availability of Papers

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In left photo one sees an aerial view of Toronto. The Royal York Hotel, headquarters for the ASME-IPE-EIC Production Engineering Conference, May 10–12, is shown in the **center** foreground. In **right photo** is Princes' Gates, entrance to the Canadian National Exhibition Park, where the Canadian National Industrial Production Show will be held concurrently with the Conference. The show, held biennially, is an exhibit of the latest in metalworking, fabricating, and productive equipment, techniques, and materials.

Session 2 **2:30 p.m.**

Comparison of Land and Crater Wear,[1] by *D. Kececioglu*, Allis-Chalmers Mfg. Co., and *Arthur Sorenson, Jr.*, General Motors Corp., Milwaukee, Wis.

Free Machining Steel, by *E. Usui* and *M. C. Shaw*, M. I. T., Cambridge, Mass. (Paper No. 61—Prod-4)

Flank Friction Studies of Carbide, by *E. G. Thomsen, S. Kobayashi*, Univ. of California, Berkeley, Calif., and *A. G. MacDonald*, Aeronutronics Space Technology Operations, Newport Beach, Calif. (Paper No. 61—Prod-3)

Session 3—Panel **2:30 p.m.**

Machine and Tool Programming Data Preparation

Panel Moderator: *W. W. Gilbert*, General Electric Co., Schenectady, N. Y.
Panel members to be announced

▶THURSDAY, MAY 11

Session 4 **9:30 a.m.**

Metal-Cutting Analysis—Re-Evaluation and New Method of Presentation of Theories, Part 1 by *S. Kobayashi* and *E. G. Thomsen*, Univ. of California, Berkeley, Calif. (Paper No. 61—Prod-1)

Metal-Cutting Analysis—New Parameters, Part 2, by *S. Kobayashi* and *E. G. Thomsen*, Univ. of California, Berkeley, Calif. (Paper No. 61—Prod-2)

[1] Paper not available—see box on page 109.

Review of Metal Cutting,[1] by *William Pentland*, Cornell Univ., Ithaca, N. Y.

Strain Rate Distribution During Experimental Metal Rolling,[1] by *K. S. Yajnik* and *J. Frisch*, Univ. of California, Berkeley, Calif.

Session 5 **9:30 a.m.**

Optical Check-Out of Large Machine Tools,[1] by *G. W. Donald*, General Electric Co., Pittsfield, Mass.

Self-Checking Characteristics of Alignment Instruments,[1] by *A. W. Young*, Engis Equipment Co., Chicago, Ill.

A Graphical Analysis of Regenerative Machine-Tool Instability,[1] by *S. Tobias*, Univ. of Birmingham, England

Session 6 **2:30 p.m.**

On Determining the Hardness of Grinding Wheels,[1] by *L. V. Colwell, Keith Soderlund*, Univ. of Michigan, Ann Arbor, Mich., and *R. O. Lane*, The Macklin Co., Jackson, Mich.

Use of Abrasive Belts and New Applications,[1] by *D. H. Knapp, Jr.*, Carborundum Co., Niagara Falls, N. Y.

▶THURSDAY, MAY 11

Session 7—Panel **2:30 p.m.**

Unification of Instruction Media for Production Machines

Panel Moderator: *J. M. Brown*, Western Electric Co., Princeton, N. J.
Panel members to be announced

Session 8 **8:00 p.m.**

Copac—A New Concept in Production Control,[1] by *R. L. Martino*, Mauchley Associates Ltd., Toronto, Ont., Canada

Programming and Other Preliminary Considerations Relating to High-Precision Three-Dimensional Modelmaking With a Computer-Controlled Machine Tool,[1] by *National Research Council of Canada*, Ottawa, Ont., Canada

▶FRIDAY, MAY 12

Session 9 **9:30 a.m.**

Diamond-Cutting Tools Engineered for Production,[1] by *Jan Taeyaerts*, Precision Diamond Tool Co., Elgin, Ill.

Economics of Machinery Replacement,[1] by *Leonard Klein*, Western Electric Co., Kearny, N. J.

Session 10—Materials Handling and Production Control **9:30 a.m.**

Management Operating Systems,[1] by *R. N. Easun* and *R. C. Carrol*, IBM, Toronto, Ont., Canada

Investing in Better Materials Handling,[1] by *K. Trickett*, United Kingdom

Measuring Material-Handling Work,[1] by *J. A. Brown*, Woods, Gordon & Co., Toronto, Ont., Canada

ASME Elects Twelve to Grade of Fellow

The American Society of Mechanical Engineers has honored twelve of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow, one must be an engineer with acknowledged engineering attainment, have 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and be a Member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or Members of the Society to the Council, to be approved by Council.

The men who were so honored for their outstanding contributions to their profession and to the Society are:

W. A. Brecht

Winston Allen Brecht is executive assistant to the general manager of Bettis Atomic Power Laboratory, Pittsburgh, Pa., an AEC-owned facility operated by Westinghouse Electric Corporation. Mr. Brecht has worked with Westinghouse since 1922, when he joined the corporation as a member of the graduate-student training course after receiving a BS degree in mechanical engineering from the Pennsylvania State College. He has exerted profound effect on present-day engineering in the transportation industry. In his various capacities with Westinghouse he has helped to forward practically every technical development in the field.

As an engineer in transportation engineering activity, 1923–1934, he helped to develop the "WN" drive for electric propulsion of light-traction railway equipment, as well as other electric railway-transportation apparatus. He continued in this work from 1934 to 1938 as manager of the mechanical section of the transportation engineering department. In 1938 he became manager of the department, supervising the design of all electric, control, and mechanical equipment supplied by Westinghouse to the transportation industry, including street-railway equipment, bus, mining locomotives, multiple-unit cars, and diesel electric locomotives. He also supervised the electrification of main line railroads.

During the war he directed the design and construction of several large, secret installations for the U. S. Navy.

He received the Westinghouse Order of Merit, highest honor conferred on an employee by the company, in 1944, for his ability to visualize and interpret the needs of the transportation industry and his progressive leadership in the development of locomotive designs and drives and electrical equipment for urban transportation systems.

He directly participated in the design and manufacture of the first geared steam-turbine locomotive built in America: The Pennsylvania Railroad's Class S-2. The Westinghouse gas-turbine locomotive and the ignitron locomotive also were developed under his supervision. He has contributed especially to smaller, more efficient equipment in both the light and heavy traction fields. For example, his high-speed double reduction drive was an innovation in the street-railway field, proving so successful that a modification of it went into general use on subways and rapid transit lines throughout the country, including the New York subway.

In 1952 he became consulting engineer on the staff of the vice-president and general manager of Westinghouse East Pittsburgh Divisions, and acted as consultant on the electrification of the Spanish National Railways.

He was invited to join the technical staff of the Bettis Atomic Power Laboratory in 1953. There he advanced through several positions to his present one, participating in the development of the nuclear power plant for the atomic submarine *Nautilus*, as well as the development of other nuclear power plants for submarine and surface vessels for the U. S. Navy.

He has been granted about 35 U. S. patents, and has written many technical papers. He is a past-member of the ASME Railroad Committee, a member of AIEE and Tau Beta Pi, and past-chairman of the AIEE Land Transportation Committee.

W. H. Byrne

William Henry Byrne, whose active life as a registered professional engineer in 45 states has inspired others in the field to call him "an engineer's engineer," is a pioneer in the field of public utilities.

He is the 80th president of ASME. He owns and operates a consulting engineering firm in addition to two large general engineering-service organizations. In 1944 he organized Byrne Associates, Inc., which occupies several floors of a downtown skyscraper. It is equipped to handle engineering-service contracts for government agencies, utilities, manufacturers, and other engineering organizations such as his own consulting firm. It is currently engaged, at home and abroad, in several thermal and diesel and water-power projects, school and hospital modernization programs, industrial plants and developments, automation problems, and large incinerators. In 1946 he acquired Stevens and Wood, Incorporated (organized 1922), an old firm in the utility and industrial field. This firm has had many engagements in marine design and has specialized in air pollution, property appraisals, rate studies, mapping systems for sewerage, telephone, gas, and electric systems for the utilities.

He was educated at Stevens Institute of Technology and the Polytechnic Institute of Brooklyn from which he received his ME degree in 1923 and immediately began his career in utility operations with United Electric Light and Power Company, New York, N. Y. He started in the test department and advanced through the operating and production department in various positions. He made many studies on the economical application of heat in the Hellgate and Sherman Creek power plants. He resigned to accept a position with Furnace Engineering Company, later acquired by Combustion Engineering Corporation, advancing from service engineer on powdered fuel and boiler installation to manager of service and erection department. In 1928 he joined Stevens and Wood, Inc., as general engineer in charge of plant betterment and rehabilitation and had many important assignments in the power-plant operation, construction, and management fields. In 1930 he accepted a position as assistant superintendent of production with Cuban affiliate of American and Foreign Power Company in Cuba. He was in responsible charge of the operation and maintenance of the power plants in the system in addition to engineering planning. In 1934 the "Batista" revolution made it advisable for him to leave Cuba and he returned to the States and continued in the power field with the Hagan Corporation and the Condenser Service and Engineering Company. These companies were, respectively, in the combustion control and water treatment, and in power and marine plant-maintenance fields. In 1936 he joined the New York Public Service Commission as principal valuation engineer, serving until 1944 as a consultant to industrial concerns and public utilities, and to attorneys on engineering matters. Then he organized his own consulting firm and, in conjunction with it, formed the present principal firm of Byrne Associates, Inc.

In addition to building a group of other consulting services, he has occasionally gone into partnership with architectural and other firms on construction projects concerning specialty housing, schools, hospitals, industrial buildings, and aircraft-motor-test cells. He extended his business activities to include the field of marine design and mapping when he acquired Stevens and Wood, Inc., in 1946. He has turned his professional skill to many varied personal projects. In 1949 he was appointed by the Mayor of the City of New York to organize and direct the first Bureau of Smoke Control for the New York City Department of Housing and Buildings. He also organized and was first director of the New York City Department of Air Pollution Control, and chairman of the Joint Engineering Societies on Air Pollution for development of the New York City air-pollution control ordinances.

Among his many inventions are a successful powdered-fuel burner, a catalyst for smoke prevention, a method for closely controlling temperatures in combustion chambers, and more recently an invention for converting fuel oil into gas. He has written many technical articles on valuation and power plants and on engineering and drafting costs.

An active member of ASME since 1944, he has served the Society in numerous capacities on the National, Regional, and Section levels, and was Vice-President of Region II for two terms. He was General Chairman of the Greater New York Business Campaign for the new United Engineering Center.

He served on Agenda Committee for three years and compiled an index of all National Agenda items; he has been on the Council Committee on Staff Personnel since 1957; he was a Regional Delegate and Speaker for RDC; he was on the Nominating Committee in 1953; he is a member of the Subcommittee on Care of Steam Boilers in Service, and has also served as Election Teller and Alternate on the Nominating Committee.

On the Section level, he has served as Chairman and Treasurer of the Metropolitan Section Executive Committee. He represented the Metropolitan Section on the Joint Professional Engineer Committee for Study of the Education Law and was Chairman of, and representative of, the Metropolitan Section of the New York City Committee on Smoke Abatement which was a joint committee of The American Society of Mechanical Engineers, the American Society of Heating and Ventilating Engineers, and the National Association of Power Engineers.

In addition to ASME, he has held many offices in and is a member of the National Society of Professional Engineers, the Smoke Prevention Society of America, the American District Heating Association, the Society of American Military Engineers, the National Association of Power Engineers, and the Civil Defense Associates. He is a Life Member and past national president of the American Society of Appraisers (formerly the Technical Valuation Society) and is presently vice-president of the Kings County Chapter of the New York State Society of Professional Engineers. He is on the Board of Management of The Engineers' Club and is a Director of the Downtown Lower Manhattan Association.

He is a member of Tau Beta Pi and Pi Tau Sigma. He has received many honors in the engineering profession including a Certificate of Distinction from Polytechnic Institute of Brooklyn, the "Engineer of the Year" award from the Phoenix Chapter of the National Association of Power Engineers, and the Sixth Annual Honor Award of the Kings County Chapter of the New York State Society of Professional Engineers in addition to five Merit Awards bestowed upon him by The American Society of Mechanical Engineers.

C. E. Crede

Charles Edwin Crede is an internationally known authority in the field of shock and vibration, and author of the book "Vibration and Shock Isolation," the first and only treatise in this field. He is professor of mechanical engineering at the California Institute of Technology, having charge of basic undergraduate courses in mechanics and supervising graduate student thesis research in mechanical vibration. He has a BS from the Carnegie Institute of Technology (1935), and an MS from the Massachusetts Institute of Technology (1936), both degrees in mechanical engineering. His formal education, plus a long and influential career in government service and in private business, has amply qualified him for his present post.

From 1936 to 1942 he worked with the Standard Railway Equipment Manufacturing Company as a development engineer on railroad rolling stock and

1961 RAC Meetings Schedule

Date	Days	Location	Hotel	Region	Section
March 27–28	Mon.-Tues.	Lancaster, Pa.	Stevens House	III	Susquehanna
Apr. 4–5	Tues.-Wed.	Tulsa, Okla.	Ramada Inn Motel	X	Mid-Continent
Apr. 7–8	Fri.-Sat.	Seattle, Wash.	Edmund Meany	IX	Western Washington
Apr. 15–16	Sat.-Sun.	Atlanta, Ga.	Henry Grady	IV	Atlanta
Apr. 19–20	Wed.-Thurs.	Denver, Colo.	Denver-Hilton	VIII	Rocky Mountain
Apr. 21–22	Fri.-Sat.	Kansas City, Mo.	Muehlebach	VII	Kansas City
Apr. 24–25	Mon.-Tues.	Dayton, Ohio	Van Cleve	V	Dayton
Apr. 28–29	Fri.-Sat.	Louisville, Ky.	Sheraton	VI	Louisville
May 1–2	Mon.-Tues.	Suffern, N. Y.	Motel on the Mountain	II	North Jersey
May 5–6	Fri.-Sat.	Waterbury, Conn.	Roger Smith	I	Waterbury
Palm Sunday	March 26				
Good Friday	March 31				
Easter Sunday	April 2				

heat-flow research; and then as assistant to the patent counsel. He is registered to practice before the Patent Office.

At the beginning of World War II, he entered the Navy Department as a civilian engineer in the Electrical Section of the Bureau of Ships, Washington, D. C. He worked on the development of means to protect shipborne equipment from the severe shock encountered in naval warfare. He helped to formulate Navy policy on shock isolators, and prepared the first standard practice manual on the subject. In 1944 he was assigned to the Naval Research Laboratory, where he organized and directed the Shock and Vibration Division, carrying out a research and test program on naval equipment.

After the war, he entered private industry as vice-president and chief engineer of Barry Controls, Inc., Watertown, Mass., a concern engaged in the control of shock vibration and noise. He resigned this position in 1958 to accept a position on the faculty of the California Institute of Technology. He has contributed papers to the journals of the engineering societies and to the technical press, and holds a number of patents on railway-car structures and vibration-control devices. He is coeditor with Cyril M. Harris of the "Shock and Vibration Handbook," to be published by McGraw-Hill in 1961.

He has been a member of ASME since 1936, and has served the Society as National Vice-President, 1955–1958, and as Chairman of the Boston Section. At the Annual Meeting of ASME in 1959, he was awarded the Machine Design Medal. He is a past-chairman of the Committee on Shock and Vibration Committee of the ASME Applied Mechanics Division. He organized the ASME Research Project on Random Vibration and is Chairman of the supervising committee. He is a Fellow of the Acoustical Society of America and a member of SESA, ASEE, Tau Beta Pi, Pi Tau Sigma, Theta Tau, and Phi Kappa Phi. He is a registered professional engineer in the Commonwealth of Massachusetts.

M. P. O'Brien

Morrough Parker O'Brien retired in 1959 from his post as Dean of the College of Engineering at the University of California, Berkeley. Then age 56, he left behind an impressive career as teacher and academic administrator to engage actively in equally important work on the organization, management, and appraisal of industrial research and development projects.

Graduated in civil engineering from the Massachusetts Institute of Technology in 1925, Dean O'Brien took graduate work in mechanical engineering at Purdue University during 1925–1927, while serving first as graduate assistant in civil engineering and later as research assistant in the equipment station. During these same years, he worked summers as chief of party on railway, highway, and property surveys for the Sacandaga Reservoir of the Hudson River Regulating District. In 1927 he was awarded an ASCE John R. Freeman Scholarship and during the following year studied hydraulic machinery and hydraulic structures at the Technische Hochschule, Danzig, and the Royal College of Engineering, Stockholm.

In 1928, Dean O'Brien was appointed assistant professor of mechanical engineering at the University of California, Berkeley, where he served continuously, except for leaves of absence, until the time of his retirement. His first assignments at Berkeley were the hydraulic laboratory and courses in hydraulics and hydraulic machinery. He was advanced to associate professor in 1931, and to professor in 1936. He served as chairman of the Department of Mechanical Engineering from 1937 to 1943, when he was appointed Dean of the College of Engineering and Professor of Engineering. During his tenure as dean, he gave major emphasis to the development of graduate study and research and to modernization of the undergraduate program.

Dean O'Brien has combined his considerable faculties for teaching, research, and professional engineering, actually interweaving these throughout his amazing career. In 1929, he organized and initiated a program of research on shoreline processes and coastal engineering for a board appointed by the Chief of Engineers of the Army; subsequently, Congress established this work on a permanent basis under the U. S. Beach Erosion Board. Dean O'Brien has served as a member of this board since 1938. He has maintained an active interest in ocean waves and shoreline phenomena as a sort of professional hobby. During the war years, this interest led to work on the design of landing craft, on forecasting surf conditions, and on intelligence studies of landing beaches. Following the war he served as Chairman of the ad hoc committee on Amphibious Operations of the National Research Council which reviewed the plans for modernization of the Marine Corps. Consulting engagements in the fields of coastal engineering included restoration of the beach at Santa Barbara, regulation of the estuary of the Columbia River, and other similar Pacific Coast problems.

Dean O'Brien's research on hydraulic machinery led to many practical applications by industry. Most of the jet pumps sold in the United States follow the designs of O'Brien and Gosline. Application of the theory of airfoils to the design of propeller pumps by O'Brien and Folsom provided the basis for extensive production of low-head, high-capacity pumps for irrigation and drainage. Consulting engagements on hydraulic machinery during this period included Byron Jackson, Food Machinery, Fairbanks-Morse, Becker Pump, Navy De-

partment, Corps of Engineers, and many other governmental agencies. His experience with turbomachinery led to his appointment in 1950 as a consulting engineer by the Aircraft Gas Turbine Division of the General Electric Company, an association which has continued to the present. He is now a consultant to the Flight Propulsion Division and the Defense Electronics Division of GE, dealing with both technical and management problems of jet engines, missiles and space vehicles, ordnance, and electronic systems.

During the war years, Dean O'Brien directed the University of California's program of engineers' science and management war training for technical and professional personnel in the aircraft and shipbuilding industries. During the four years of its existence, this program included 1800 instructors and 46,000 students. Concurrently, he served as dean of the college and as a consultant in the research section of the Bureau of Ships on problems of submarine propeller noise, and on amphibious operations. In 1946, he participated in Operation Crossroads at Bikini as a consultant on the measurement of waves generated by the bomb tests; most of the photographs of the Baker tests, which appeared in the press, were taken by the tower and aerial cameras which Dean O'Brien and his associates operated for wave measurements.

Twice, he has taken full-time leave from academic duties to engage in engineering practice; once, 1947 to 1949, to serve as director of research and engineering with the Air Reduction Company and, again in 1953, to join General Electric Company's Aircraft Nuclear Propulsion Project. He has held membership on many influential boards and commissions, among them the Beach Erosion Board; the National Science Foundation's panel of engineering consultants; the Army Scientific Advisory Panel; the Atomic Energy Commission's personnel security board; the Maritime Research Advisory Committee and the Advisory Board on Education of the National Academy of Sciences, National Research Council; and the board of directors, McGraw-Hill Publishing Company. In 1958 President Eisenhower appointed him a member of the Board of the National Science Foundation. During 1958–1959, he was a visiting institute professor at the Massachusetts Institute of Technology, and a visiting research fellow at Harvard University.

In 1959 he became professor-emeritus of engineering and dean-emeritus of the college of engineering at the University of California. He continues his academic association as a consulting professor at Rensselaer Polytechnic Institute, Polytechnic Institute of Brooklyn, and Purdue University.

He has served ASME since 1929, receiving the Certificate of Appreciation from the Society in 1955, and has worked on the Special Research Committee on Fluid Meters, the Medals Committee, the Executive Committee of the Hydraulic Division, and the Education Committee. He was chairman of the San Francisco Section in 1947. Among other awards he has received are the Army-Navy Certificate of Appreciation, an ASCE citation, and an honorary DS degree from Northwestern University.

He has written more than 80 published articles on technical subjects and engineering education, and is co-author of "Applied Fluid Mechanics," published by McGraw-Hill in 1937.

He has been active in many professional societies. Present and past memberships include ASME, ASCE, ASEE, Association of American Military Engineers, AGU, ARS, ANS, California Society of Professional Engineers, NSPE, IAS, Society of Limnology and Oceanography, AAAS, History of Science Society, Permanent International Association of Navigation Congresses, Society for the History of Technology, International Association of Hydraulics Structures Research, Svenska Teknologforeigen, Newcomen Society of Great Britain, Pi Tau Sigma, Tau Beta Pi, Chi Epsilon, and Sigma Xi. He is a member of the Bohemian Club of San Francisco, the Cosmos Club of Washington, the Athenian-Nile Club of Oakland, and The Engineers' Club of New York. He is a registered professional engineer in the states of California and New York.

W. P. Saunier

WILLIAM PERKINS SAUNIER is project manager with Jackson and Moreland, Inc., Boston, Mass. Since the beginning of his association there in 1941 he has been responsible for the design and installation of electrical power units that now produce two out of every three kilowatt hours generated for public sale in the greater Boston area. Among these are the three 85,000 kw reheat units at Edgar Station, the first of which was the largest generating unit in New England at the time of its installation. It was later outrivaled in capacity by the first of three 125,000 kw units at Mystic Station, also installed under the direction of Mr. Saunier. Both projects were completed for the Boston Edison Company.

Mr. Saunier was graduated in mechanical engineering from Rensselaer Polytechnic Institute, establishing his specialty in steam-electric power plants. For 18 years prior to 1941 he was a sponsor engineer with W. S. Barstow and

1961 Regional Student Conferences Schedule

Date	Days	Host Section	Region	Location
April 21–22	Fri.-Sat.	Brown University	I—New England	Providence, R. I.
April 29	Sat.	The Cooper Union	II—Eastern	New York, N. Y.
April 21–22	Fri.-Sat.	Howard University	III—Alleghenies	Washington, D. C.
April 14–15	Fri.-Sat.	Georgia Institute of Technology	IV—Southern	Atlanta, Ga.
April 14–15	Fri.-Sat.	University of Toledo	V—Midwest	Toledo, Ohio
May 5–6	Fri.-Sat.	Michigan College of Mining and Technology (Sault Ste. Marie Div.)	New VI and VII—North	Houghton, Mich.
April 14–15	Fri.-Sat.	University of Illinois	New VI and VII—South	Urbana, Ill.
April 17–18	Mon.-Tues.	University of Oklahoma	New VII and X NOAK	Norman, Okla.
April 21–22	Fri.-Sat.	University of Colorado	New VIII Rky. Mt.	Boulder, Colo.
May 4–5	Thurs.-Fri.	University of Washington	New IX—Pacific NW	Seattle, Wash.
April 28–29	Fri.-Sat.	University of Arizona	New IX—Pacific SW	Tucson, Ariz.
April 15	Sat.	University of Texas	New X—Gulf States	Austin, Texas

Company, and successor companies in Reading, Pa., having charge of the design, specification, and construction of steam-electric power-plant units at Gowdy Station, Binghamton, N. Y.; Seward Station, Johnstown, Pa.; Oil City Station, Oil City, Pa.; and Gilbert Station, Holland, N. J. Later, with Jackson and Moreland, Inc., he also directed the installation of turbine generators at Mason and Wyman Stations for the Central Maine Power Company. In addition, he did consulting work for a number of other utility and industrial power plants. He co-authored articles on Boston power units that appeared in the magazines *Combustion* and *Power Plant Engineering*.

A member of ASME since 1929, he was chairman of the Boston Section, 1945–1946, and has served on the ASME committees on Organization, Medals, and Professional Practice. A member of the Massachusetts Society of Professional Engineers, he was chairman of its metropolitan Boston chapter from 1949 to 1950. He is a registered professional engineer in the State of New York and Commonwealths of Pennsylvania and Massachusetts.

R. E. Sprenkle

RAYMOND E. SPRENKLE has greatly contributed to the advancement of the art of flow measurement as a hydraulic engineer with Bailey Meter Company, Cleveland, Ohio. Mr. Sprenkle joined the company 41 years ago as a cadet engineer. A native of Waynesboro, Pa., he had by mid-1917 earned a BS in mechanical engineering at Bucknell University, Lewisburg, Pa. Twenty years later, he had earned an MME degree.

Soon after joining Bailey Meter Company in 1919, he began selling and servicing Bailey products, and advising on their application throughout the territories of western Pennsylvania, southeast Ohio, and northern West Virginia. Two years later, when he became head of the meter engineering department, he assumed responsibility for all research on flow primary elements within the company, as well as similar work carried on at Ohio State University.

He became director of education of the company in 1944. As such, he directs the recruiting and the training of newly hired engineers, and the education of customers through courses on instruments and automatic control. He also serves as a consultant on flow problems and flow primary element testing.

He has served ASME since 1927, most notably as an active member and Vice-Chairman (1955–1959) of the Fluid Meters Committee, and as Chairman of several of its subcommittees. He served on a subcommittee in preparation for the fourth and fifth editions of the ASME report on "Fluid Meters, Their Theory and Application," as well as the Power Test Code Committee No. 19/c on Instruments and Apparatus in preparation for Chapter 4 (1959) Flow Measurement-Instruments and Apparatus; and as a member of the executive committee of ASA B31 Code for Pressure Piping. He also served as the ASME representative on the Cleveland Technical Societies Council, and more recently as a member of the American Delegation to Germany and France for the plenary meetings of the International Organization for Standardization of Flow Metering. He is the author and co-author of a number of ASME papers on flow measurement, and several ISA papers.

The Third Annual Hydraulic Conference, Monday through Thursday, May 7–11 1961, Montreal, Que., Canada

THIS conference will take place at the Queen Elizabeth Hotel and will be sponsored jointly by the Hydraulic Division of The American Society of Mechanical Engineers and The Engineering Institute of Canada.

In the past three years this conference has developed greatly in scope. This year's program is the most comprehensive yet, and covers many areas of hydraulics that are of current interest. The conference will include 15 technical sessions and inspection trips, and careful screening of technical paper insures a high quality of the subjects covered.

One of the high lights will include an inspection trip of the major engineering features of the St. Lawrence Seaway. This trip will be made by boat, and a luncheon will be included.

The fields of hydraulics to be covered include: Prime movers, fluid mechanics, cavitation, hydrology and ice, water hammer, compressors, and pumps.

For the women who plan to attend the conference, a special program has been set up which provides trips to the various points of interest that Montreal has to offer.

Specialists in their field have been invited to address the conference.

An early issue of MECHANICAL ENGINEERING will include a complete program showing all the technical sessions as well as various other events.

C. Carmichael

COLIN CARMICHAEL is a voice of the design engineering profession from his position as editor of *Machine Design* magazine. As editor for more than a decade, he has been responsible for the dissemination of an increasing flow of technical information to engineers throughout the country. His editorials have been signposts in the profession, and, through co-sponsorship of mechanisms conferences with Purdue University, he has further helped to stimulate the exchange and development of technical knowledge. Mr. Carmichael has served the profession voluntarily in many ways and is a recognized engineer and teacher.

For the past five years, he has been a consultant and member of the Picatinny Arsenal Scientific Advisory Council, and last year he accepted an invitation of the Pennsylvania State University to serve on its industrial and professional advisory council. His authoritative voice as an editor and consultant has grown out of years of practical experience as a mechanical engineer. Born in Glasgow, Scotland, in 1905, he became a United States citizen in 1940, gaining his education and experience on both sides of the Atlantic. He received a BS degree in engineering from the University of Glasgow in 1926, and an MS in mechanical engineering from the University of North Carolina in 1934. He served an apprenticeship with Glasgow shipbuilders, and at the age of 23 was a seagoing engineer out of Southampton, England. This background he applied in his early employment in this country with Sun Shipbuilding and Drydock Company, Chester, Pa., where he was a draftsman.

Education has been an important facet of his career since 1931, when he became an instructor in mechanical engineering at the University of North Carolina. He was an assistant professor in 1934. He also was an assistant professor of machine design at Cornell University, and of mechanical engineering at Rutgers University.

He entered the publishing field in 1942 as associate editor of *Machine Design* with Penton Publishing Company, Cleveland, Ohio. Seven years later he became editor. Since 1942 he has contributed many technical articles to the magazine, and has given his time to

several other publications. He personally edited and wrote some sections of the 1950 edition of "Kent's Mechanical Engineers' Handbook," Design and Production Volume. He also has contributed to the *Journal of Engineering Education* and the "Encyclopaedia Britannica."

He has been a leader in the development of ASME. He was one of the founding fathers of the national Machine Design Division, serving as Chairman of the division during its early period. He was a member of the original Machine Design Division Subcommittee that planned and developed the ASME Design Conference beginning in 1956. More than ten years ago he accepted an ASME assignment to head the ASA Committee B55 on V-belts. As a result of his persistence, the first approved ASA standard in this field will be issued in the near future. He has served on the ASME Publications Committee, was chairman of the Machine Design Division Executive Committee in 1950, and has served on the Cleveland Section Executive Committee and the Cleveland Section Honors and Awards Committee. He holds membership in ASEE, SAE, NSPE, the Society of Business Magazine Editors (of which he was president in 1959), the Cleveland Engineering Society, AOA, the Institution of Engineers and Shipbuilders in Scotland, Tau Beta Pi, and Sigma Delta Chi. He is a registered engineer in the State of Ohio.

M. B. Hogan

MERVIN BOOTH HOGAN, engineer and educator, is manager of reliability engineering in General Electric Company's heavy military electronics department, Syracuse, N. Y. Before joining General Electric in 1956, he served for 25 years on the mechanical engineering faculty at the University of Utah. He graduated from the university with a BS degree in mechanical engineering in 1927, received an MS degree from the University of Pittsburgh in 1929, and a PhD from the University of Michigan in 1936. He did graduate work at Yale University as a Sterling Fellow in mechanical engineering, 1937–1938.

He was with Westinghouse Electric Corporation, East Pittsburgh, Pa., as an engineer for four years after receiving his first degree, and in 1931 became an assistant professor in mechanical engineering at the University of Utah. He was an associate professor in 1936, and a professor in 1939. He was appointed chairman of the university's mechanical engineering department in 1952, remaining at that post until 1956. During his teaching years, he spent several summers on naval projects. In the summer of 1941 he was working on automatic computers for Navy gun control with the General Electric Company, and he spent the summer of 1945 working on automatic fire control apparatus for Navy planes, an OSRD project at the University of Minnesota. He also was co-director of a Navy research project on creep of solids at the University of Utah, 1948–1956. He became a consulting engineer on design problems for the Chicago Bridge and Iron Company in 1955, working out of their Chicago and Salt Lake City plants. Then he began consulting work on mechanical reliability in the heavy military electronic department of General Electric.

Mr. Hogan has authored a number of papers and several naval research technical reports. He has served ASME in many capacities, as Secretary, Vice-Chairman, and Chairman of the Utah Section, and as a member of the Utah Section Executive Committee. He received the ASME Certificate of Appreciation for his work with the section. He was General Chairman of the 1947 ASME National Fall Meeting in Salt Lake City, and a founding member of the University of Utah Student Section, established in 1926. He has been a member of the Executive Committee of the Syracuse Section since 1957, and has twice been Chairman of the Syracuse Section Program Committee.

He holds membership in Tau Beta Pi, Pi Tau Sigma, Phi Kappa Phi, Sigma Xi, Sigma Pi Sigma, Theta Tau, the Yale Engineering Association, and the Scientific Research Society of America. He is a senior member of IRE, and a member of The Institution of Mechanical Engineers, London. He is a registered professional engineer in the states of Michigan, Connecticut, Utah, and New York.

R. Michel

RUDOLPH MICHEL is a project engineer and consultant in the Nuclear Power Department of Allis-Chalmers Manufacturing Company, Washington, D. C.

Both an educator and a design engineer at various times during his career, his most outstanding contribution to science has been the introduction of modern analytical methods of computation relating to power-plant design of naval vessels. He has formulated design data sheets for naval-shipyard and industrial use in standardizing computation methods for ships' power plants; and has been responsible for innovations leading to weight reduction in naval power plants. In this area, he made the first studies on the feasibility of gas turbines for naval propulsion, supervised the design of noise isolation methods of the *USS*214, the first submarine to be completely noise-isolated, and introduced modern planetary gears for main propulsion. He was a member of the Main Machinery Panel of the Design Co-ordinating Committee, Bureau of Ships, 1952–1954, and chairman of the Bureau of Ships Education and Training Committee, 1948.

Mr. Michel was graduated from the University of Wisconsin with a BS degree in mechanical engineering in 1916; and was an assistant professor of graphics and analytical mechanics at the University of Illinois, from 1923 to 1929, receiving an MS there in 1928. Then he went with Westinghouse Electric Company as a design engineer in the turbine engineering department at the South Philadelphia works and later as a mechanical design engineer with Poole Engineering and Machine Company, Baltimore, Md.

He began a long career with the Navy Department in 1933, starting as a tool designer for one year at the Naval Gun Factory, Washington, D. C., and spending the remaining years up to 1958 in the Bureau of Ships. During most of these years he also was engaged as a part-time professor of dynamics at the College of Engineering of the George Washington University. For ten of those years, he was head civilian engineer in charge of power-plant design of new warships. He organized the Scientific and Performance Section, which was responsible for the preliminary design of power plants for all warships. In 1945 he was a member of the Navy Technical Mission to Europe to investigate the status of German technical developments. He joined Allis-Chalmers, 1958.

He has written a number of papers and articles, some of which have appeared in the *Transactions of The ASME*, the *Engineering Bulletin of BuShips*, the *Journal of the American Society of Naval Engineers*, and the *Marine Engineers and Shipping Review*, England. He received a Meritorious Award from the Bureau of Ships in 1955, in recognition of his services in the field of marine engineering.

He has served ASME as Chairman of the Washington, D. C., Section, 1945; of the Program Committee, 1943; and the National Agenda Committee, 1947. He is a member of the Executive Committee for Steam Properties Research, and served for five years on the ASME-ASA B31 Committee, Code for Pressure Piping. He also is a member of the SNAME and the American Society of Naval Engineers. He is a registered professional engineer in Maryland.

R. L. Scorah

RALPH L. SCORAH has been chairman for many years of the department of mechanical engineering at the University of Missouri, a position he reached through years of service on the university faculty, and to which he has brought experience of an impressive professional nature. He was director of an Engineering, Science, War Training Course (ESMWT), Defense War Training Course in 1942, in which instruction ran day and night to train the WPA of Central Missouri for service in war industries. During the war he also was a member of the local War Fuel Conservation Board serving Columbia, Mo. From 1951 to 1952 he was adviser to the U. S. Office of Education on the evaluation of military courses. His academic contributions at the University of Missouri have included revising the mechanical-engineering curriculum, and, from 1935 to 1942, designing and constructing the heat-power and machine-tool labs and later enlargements.

He began his career at the university in 1935 as an assistant professor in mechanical engineering, bringing with him an already impressive background gained at Purdue University, where he earned his BS and MS degrees, 1924–1925, and at the University of Illinois, where he was an instructor, 1929–1932, and the recipient of a PhD degree. He was a Celite Research Fellow at the Purdue Engineering Experiment Station in 1924, working on the conductivity at high temperatures of heat-insulating materials. In 1932 he also received an ME degree at Purdue University, that same year becoming a full-time instructor in mechanical engineering at Stanford University, where he remained until 1935. He advanced to an associate professorship at the University of Missouri in 1939, becoming chairman of his department in 1940, and a full professor in 1942.

As a professional engineer, Mr. Scorah spent consecutive periods from 1925 to 1929 with Cincinnati Milling Machine Company, Cincinnati, Ohio, on design; with Union Gas and Electric Company, Cincinnati, as a power engineer; and with Northwest Engineering Company, Green Bay, Wis., as an experimental engineer.

He has authored many articles on heat transfer and fluid mechanics, some of which have appeared in *Machine Design*, *Power Plant Engineering*, *Combustion*, *Journal of Chemical Physics*, and *Transactions of the ASME*.

He has served ASME as Honorary Chairman of the Missouri ASME Student Section, a member of Region VI Administrative Conference, 1949–1951, and speaker on the ASME Junior Panel, Semi-Annual Meeting, 1952. He was Chairman of President Morgan's Kansas-Missouri Anniversary Meeting and Presentation of the Holley Medal, 1955; Chairman of President Ryan's Organization Meeting for Mechanical Engineering Department Heads, 1957–1958; and Chairman of the St. Louis Student Section Committee, 1958.

He also is a member of Pi Tau Sigma, Tau Beta Pi, Sigma Xi, ASEE, ECPD, and the American Association of University Professors. He joined ASME as a Junior in 1926, and at present he serves as the Secretary of the St. Louis Section.

C. H. Shumaker

CLIFFORD HAROLD SHUMAKER has been associated with Southern Methodist University since 1930. He has been chairman of the university's department of industrial engineering since its establishment in 1952, when he was responsible for organizing its curriculum and faculty. Since 1948 he has been the director of the Institute of Management, jointly established in that year by SMU and the Texas Manufacturers Association for the purpose of training management personnel.

Mr. Shumaker received his education at the University of Kansas, where he received a BS in industrial engineering in 1930, and an ME in 1944. He began his career at SMU in 1930 as an instructor in mechanical engineering, but left the academic trail in 1933 to take charge of an industrial survey of Kansas as a research assistant for the Kansas State Planning Board, Topeka. Upon completion of the survey, he worked as a draftsman with the Kansas State Fish and Game Commission, Salina, in connection with the design of numerous state dams. He was an assistant chief draftsman in 1935 with the engineering consulting firm of Paulette and Wilson, and then returned to SMU as an assistant professor in 1936, successively becoming associate professor and professor of mechanical engineering.

In addition to his teaching duties, he directed the War Training Program at SMU from 1940 to 1944; the Ordnance Gage Laboratory, established there in 1946; and the Institute of Building Material Distribution from 1947 to 1956.

He has served ASME as Vice-President of Region VIII, and member of the Medals Committee and Organization Committee. He holds the ASME Certificate of Award. He also is a member of ASEE, American Institute of Industrial Engineers and Sigma Tau, and is a recipient of the Sigma Tau Medal. He is a registered professional engineer in the State of Texas.

Revision of ASME Constitution, By-Laws, and Rules

To: Members of ASME

UPON authorization of the Council a few years ago, a subcommittee of the Constitution and By-Laws Committee was appointed "to consider and prepare a general revision of the Constitution, By-Laws, and Rules." G. M. Muschamp, *Chairman*, L. E. Herbert, and L. C. Smith who comprise the subcommittee, worked on the revision for more than two years and it is now ready for submission to the Council for action at its meeting in Los Angeles, Calif., June 11–12, 1961.

No substantive changes have been made but inconsistencies and duplications have been eliminated and, in particular, the form and arrangement of the matter have been revised.

On the assumption that the Council will make no changes in the revision there will be a presentation at the Business Meeting in Los Angeles, June 12, 1961, by the Constitution and By-Laws Committee of proposed transposition of 18 Constitution items to By-Law status and the transposition of seven By-Law items to Constitution status. Copies of these items will be available at the Business Meeting. After discussion and possible modification at the Business Meeting these items will be mailed, about Aug. 15, 1961, to the membership for letter-ballot action.

A limited number of copies of the 40-page revision is available upon request from the Secretary's Office, 29 West 39th Street, New York 18, N. Y.

R. D. Webb

RALPH DUVIVIER WEBB, outstanding authority on industrial instrumentation, participated in founding the IRRD of ASME in the 1930's and the Instrument Society of America in the late 1940's. He has played a prominent part in the growth of instrumentation by striving to make management aware of its importance in the process industries. He is director of instrumentation and associate director of engineering at Union

Carbide Olefins Company, South Charleston, W. Va., and was primarily responsible for the establishment of the company's special instrumentation department. He has been with Union Carbide Corporation since 1924.

His contributions in the field of instrumentation have included aiding instrument manufacturers toward the making of more precise and various types of automatic control devices. He encouraged the development of analytical instruments for on-line process control, and the development of the pneumatic transmission system. He also engineered instrumentation of the large butadiene processes for automatic operation to provide the government with the raw materials for making artificial rubber during World War II.

Mr. Webb went to work with Union Carbide Corporation in Clendenin, W. Va., in 1924, after graduating with a BS degree in mechanical engineering from the University of Illinois. As a process engineer, he worked in several divisions of the company, first with the Natural Gasoline Stabilizing Unit, then with the Methanol Plant at Niagara Falls, N. Y. In 1933 he was transferred to the South Charleston plant and placed in charge of all instrument work. He was appointed associate director of engineering in 1957.

A number of his writings have appeared in engineering publications, including *Instruments*, *Petroleum Processing*, *ISA Journal*, *Southern Power and Industry*, and *Petroleum Refiner*. He has been a member of ASME since 1942. He is an honorary member of ISA, a fellow of AAAS, and a member of Pi Tau Sigma, Tau Beta Pi, and Sigma Tau.

Conducted for the National Junior Committee

J.W. FOLLANSBEE[1]

JUNIOR FORUM

Introduction to Operations Research

By Albert S. Goldstein[2]

"Operations Research" is a phrase that has become popular in business circles and to the general public. Since it is applicable to many fields in both industrial and government operations, it is in danger of obtaining a rather nebulous connotation. Much to the chagrin of OR enthusiasts, the phrase is approaching the meaning of a word like "engineer," which could mean a train operator, a rocket engineer, or a wide variety of occupations. To add to the confusion one will find many other labels that have approximately the same or closely related meanings. (For instance, management science, data processing, scientific decisionmaking, systems analysis, optimization.)

Many people of various backgrounds and education have suddenly become operations researchers. For one reason, the title can be applied to almost any orderly method of investigation, analysis, and recommendations having to do with operations involving people and money. And this also indicates why there are so many labels applied to approximately the same basic concept.

But OR isn't a new device or method. It is, by definition, an orderly discipline evolved from common sense, keen observation, analytical ability, and competence in several scientific fields. It's a discipline which applies basic scientific principles to the over-all operations of human enterprises in order to improve efficiency. And the characteristics just mentioned are deeply rooted in the basic sciences and new analytical techniques developed after World War II.

Although OR methods are called scientific, their application is not limited to highly technical industries. These methods have already served many commercial concerns and government agencies. Examples: Walt Disney Enterprises, the armed services, and department stores.

Potential uses of OR principles for improving almost every facet of life increase daily. This is not to say that something completely new has been discovered. Business people have been using scientific principles for running an enterprise long before the name Operations Research came into being. However, their scientific methods were comparatively crude and their capabilities were limited. The important thing to remember is that the same steps and procedures apply to many different situations. Therefore, if an orderly and well-defined method of attacking problems is evolved, it can prove invaluable in many areas of human endeavor.

The basic steps of an Operations Research project are: (1) To determine the *real* problem, (2) study the problem and collect the essential data, (3) analyze the data, (4) devise a model or a solution to the problem, (5) test this model or solution, and (6) implement the solution. Note that this is more commonly known as the scientific method.

The reason for the first step is that the real problem in an enterprise is usually clouded or poorly stated. Nothing can be effectively accomplished until the problem is clearly defined. The second, third, and fourth steps naturally follow after the problem is defined. Here is where the basic sciences, new analytical procedures, and our modern electronic computers are applied. The testing of the model steps or solution in many cases might be impractical, but if testing is possible, the data derived can be used to justify or modify the solution. (This is popularly known as a feedback device.)

The final step, implementing the solution, might not appear to be important. However, since we are dealing with human beings this might well be the most essential phase of an OR application. In fact, without a good salesman on the team to innovate the solution, the entire project can be a failure. This team approach idea has become an essential factor in most OR endeavors. Specialized knowledge might be needed in many areas, so it becomes desirable to combine the capabilities of many individuals for the success of an OR application.

OR received its name and impetus as a scientific method early in World War II. It was used (first by the British) to predict the best search patterns for detecting submarines and effectively destroying them. One of the first successful applications involved the timing of

[1] Designer, Voorhees, Walker, Smith, Smith & Haines, New York, N. Y. Assoc. Mem. ASME.

[2] Engineer, Heavy Military Electronics Department, General Electric Company, Syracuse, N. Y. Assoc. Mem. ASME.

detonating a bomb to destroy submarines.

The real development and beginnings of OR emerged from the Industrial Revolution. Before this era, business enterprises were operated by one individual. He performed all the management tasks of planning, purchasing, production, sales, and made all of the economic decisions affecting the enterprise. The success or failure of the business rested on the judgment and actions of one individual. With the Industrial Revolution it became impossible for one man to perform all the necessary management functions. Division of these functions and the increased complexity of industrial organizations created a need for improved methods of communications and decision making. Today, important decisions in industry are made by individuals and groups who have little or no direct contact with the actual operation. Hence it is necessary to obtain and provide information and formulate rules upon which management can base intelligent decisions. These interactions are of prime importance in an operation, since a wrong decision or improper operating procedure in one area can mean the loss of millions of dollars to the over-all enterprise. Today, top management must depend upon and interpret the information transmitted to them through the many levels of management. It is essential that some orderly method of obtaining and then using the information be followed. This is one reason why the team approach is so prevalent in OR. Knowledge in the fields of economics, mathematics, engineering, psychology, sociology, and other areas are required for many OR projects.

It was not until after World War II that the scientific principles and procedures developed during the conflict could be used for nonmilitary applications. At this same time the parallel development of large electronic computers provided further impetus to OR. Many problems, which had been considered impractical to tackle, were now within the capabilities of the operations researchers. It now became a simple task to gather data and derive solutions in minutes, a job which would have taken years without the use of high-speed electronic computers.

Most OR projects for industrial applications, at this time, were conducted by educational institutions and management consultant firms. It was not until comparatively recently that groups of this type were established by industrial concerns. Today, there is a growing number of courses being offered in the field. The increasing scope and complexity of the field deem it imperative that an operations researcher be specially trained by industry and the colleges.

At present a person with a creative mind and a good background in science, economics, and engineering can become an OR man. There is, however, a lack of personnel with formal training, so industrial firms are filling the gaps by training their own qualified people, or by using management consultants. And, many management consultant firms are also seeking people who are competent in the field.

Some of the largest users of OR methods are the oil companies and public utilities. Although many of these groups exert influence in the levels of management, it is widely thought that the proper position of such a group is a staff function in middle management. Now that the accomplishments and potentials of OR have become evident, companies are joining the rush in establishing such groups. The General Electric Company has established four OR and Synthesis groups on an experimental basis. If they prove successful, it is probable that similar groups will be established in areas ranging from appliance groups to the defense products departments.

Most management consultants have OR groups and use this new discipline in their work. An Operations Research Society was organized in the early 1950's and now publishes a monthly journal. In addition there are many books, technical papers, and reports on case studies and principles of Operations Research. W. T. M. Johnson of E. I. du Pont de Nemours & Company, Inc., epitomizes the growing importance of this new field this way: "If your business needs a doctor, his name is Operations Research."

The Need for After-College Professional Development of the Young Engineer

By John Gammell, Chairman, Committee on Development of Young Engineers, Engineers' Council for Professional Development

ENGINEERS are costly for society to produce. They are expensive to maintain. Their output is important to our continued growth, to our high standard of living, and in these times particularly to the safety of our country. It is most important that this valuable resource be used to its maximum.

The process by which a young engineer is effectively fitted to a job can be a short one or a long one but in any case it involves three steps.

First, finding the job,
Second, learning the job, and
Third, growing in the job.

Finding the right job needs attention. Because of the rapid development of science the problems of adapting a particular capability to a particular task both of which are changing rapidly is formidable. Learning the job after one gets it may be routine but keeping up is not. Someone has said that the half life of an engineer's education is 15 years. If this is true the technical deterioration of a man's education is at the rate of 3 per cent a year. If we are not to lose this technical capability a constant effort must be made to keep our people abreast of the times and also working on those jobs for which they continue to be best fitted. This effort must not be left to chance nor made exclusively dependent on good motivations or the judgment of our young engineers, but it must also be purposely planned and purposely fostered by responsible executives in industry, professional organizations, and colleges.

The ECPD's Committee for the Development of Young Engineers has addressed itself to these purposes. The building blocks of the plan are:

(1) Career orientation, (2) continuing education, (3) professional identification, (4) responsible citizenship, (5) selected reading, and (6) personal appraisal.

The means of implementation are through community action, through action of the professional societies, through industry and its training and professional development programs, and through schools, particularly those concerned with night classes and graduate activity.

Specifically, we feel that a wide distribution of literature which ECPD has prepared and discussions of the points brought up in this literature can go far to doing the job. Information on ECPD's publications can be obtained by writing to: Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N. Y.

Nominations Wanted Now!

National Nominating Committee Stresses Democratic Procedure for Finding National Officers for ASME

DURING the 1961 Summer Annual Meeting, the National Nominating Committee will meet to choose nominees for President, Vice-President of Regions I, III, V, VII, IX, and XI, and for three Directors of the Society. You are reminded that the Nominating Committee can perform its function only if the Society members provide that body with the names of outstanding individuals for consideration.

These men, as officers and spokesmen of ASME, should be leaders in our profession and in their communities.

Each member of the Society no doubt is aware of one or more such leaders in his community, Section, or Region—men who over the years have served the Society well and have helped to make ASME the world-famed organization it is. It is your duty and privilege as a member to suggest such men for consideration as officers of the Society. In addition to filling out the nomination form, it is considered proper and ethical to prepare a brochure, biography, or sketch of the personal and professional qualities of the member proposed for nomination. Such supplementary publications should be prepared strictly to disseminate information among members of the Society. It is not proper or ethical to campaign among any part of the membership to attempt to coerce or persuade in any way members of the Regular Nominating Committee. To ask or suggest to members to use their influence in securing a nomination extends beyond the bounds of ethical practice in a profession and is likely to discredit the qualifications of a member being proposed for nomination in the judgment of the nominating committee. "The office shall seek the man rather than have the man or his friends seek the office."

Each ASME Section has an adviser on nominations who will see that suggestions are forwarded to your Regional Nominating Committee Member. The latter or your Section Adviser will assist in the preparation of the nomination sponsorship form. If you do not have already the official Nominating Form you may secure such from James R. Muenger, Secretary of the National Nominating Committee, Texaco Research Center, Texaco, Inc., Beacon, N. Y.

The National Nominating Committee will meet on June 12 and 13 during the 1961 Summer Annual Meeting at the Statler Hilton Hotel, Los Angeles, Calif., to consider the prospective nominees. At this time, any member may appear before the Committee to advocate further the nomination of a candidate.

Ours is a democratic society.[1] The caliber of national officers who will direct the affairs of our Society during the next one to four years is squarely up to you. Why not do something about it? Recommend a Candidate.

[1] See Article B7, Paragraph 20, of our Constitution, ASME Manual MM-1.

ASME Boiler and Pressure Vessel Committee to Meet in Charlotte, N. C., March 12–17

THE Boiler and Pressure Vessel Committee of The American Society of Mechanical Engineers holds six meetings a year, one of which is held outside of New York City. The 1961 meeting will be held jointly with The National Board of Boiler and Pressure Vessel Inspectors at the Barringer Hotel, Charlotte, N. C. March 12 to March 17, inclusive.

Meetings will be held of the various subcommittees covering, in part, power and heating boilers as well as unfired pressure vessels. The National Board of Boiler and Pressure Vessel Inspectors also will hold sessions at this meeting. There will be addresses by the various State and City representatives.

The all-day session of the Boiler and Pressure Vessel Committee is planned for Friday. Meetings of the various subcommittees and the Boiler and Pressure Vessel Committee are open to the public.

Representatives from the Boiler and Pressure Vessel Committee and The National Board of Boiler and Pressure Vessel Inspectors as well as Region IV comprise the Planning Committee.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after March 24, 1961, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Transfers

Alabama

•HUSTON, FRED L., Birmingham

Arkansas

SAMPLE, HUGH, Arsenal

California

ATARIS, MICHAEL, Fullerton
BRAJNIKOFF, GEORGE B., Gardena
COMPTON, MARDIS C., Saratoga
DETWILER, GEORGE D., Antioch
ELLIOTT, RICHARD J., Costa Mesa
•FINNIE, IAIN, Emeryville
HANSEN, ROBERT E., Glendale
KLEIN, G. HAROLD, Canoga Park
•UNITT, STANLEY G., Los Angeles
WONG, OTTO J., Manhattan Beach
ZABARSKY, OSCAR P., West Minster

Colorado

•HARDIN, THOMAS D., Denver

Connecticut

BOUNDS, ALLEN E., Elmwood
•FRIED, GEORGE, Stamford
•HANNA, ROGER S., Hamden
KANG, CHOA S., Hartford
LYON, EDWARD W., East Hartford
VECSEY, JOSEPH A., Bridgeport

Delaware

•ROLLI, VICTOR M., Wilmington

•Transfer to Member or Affiliate.

VOIGT, HENRY K., Wilmington

District of Columbia

EVERT, RICHARD H., Washington

Florida

BELINE, MARTIN B., Miami
•BLANCHETTE, HOWARD M., Pensacola
WOLFF, CHARLES L., SR., Miami

Georgia

READY, GARY L., Atlanta

Idaho

•TRILLHAASE, MARTIN B., Idaho Falls
WOOD, LEE E., Idaho Falls

Illinois

BLANE, ROBERT N., Clarendon Hills
BUGAR, BELA A., Chicago
•DAUBMAN, EDWARD A., JR., East Moline
GAICHAS, DAVID A., Chicago
GOAR, MARK R., Moline
•HOMER, PERCY A., Loves Park
KASBEER, PHILIP F., Bloomington
•SMITH, GARLAND Y., Riverside
THOMPSON, ROBERT G., Chicago
•ZAGOTTA, JOSEPH L., Chicago

Indiana

•HARDER, JOHN E., Bloomington
HUTCHINS, GEORGE R., Indianapolis
SPAETHE, JOHN B., South Bend

Iowa

DORUMSGAARD, GERALD M., Marion
•JACOBSON, WAYNE D., Cedar Rapids
POORE, WESLEY A., Cedar Rapids

Kentucky

PARKHURST, IRA A., Paducah

Maryland

BUCKLEY, DENNIS J., Odenton
EGERTON, BENJAMIN G., Baltimore

HARRINGTON, WILLIAM M., JR., Pasadena
HILE, JOHN R., Baltimore
•PAULUS, JAMES D., Lutherville-Timonium

Massachusetts

BLISS, CHARLES, Cambridge
JACKSON, EARL G., Cambridge
•LEVITT, ALBERT P., Watertown
SHIRING, PAUL B., Boston
THEODORES, THEODORE P., North Grafton
VELTE, RICHARD G., Cambridge

Michigan

BOUGHNER, LAWRENCE G., Birmingham
DEVOS, LEON N., South Lyon
HARRIS, EUGENE R., Detroit
QUACKENBUSH, LELAND J., Ann Arbor
STEWART, ROY S., Niles
WOMELSDORF, LEROY K., Detroit

Minnesota

ARNOLD, WILLIAM F., Rochester
STROEBEL, JOHN H., Rochester

Missouri

•FRANCISCO, DILLARD M., St. Louis

New Jersey

CHUNG, JUNG K., Old Bridge
•HOLLANDER, MILTON B., Teaneck
RICCA, LUIGI, Fair Lawn
SCHWALJE, EDWARD N., Metuchen
•SMITH, PERRY M., New Shrewsbury
•SMITHBERG, EUGENE H., Newark
TIS, EUGENE P., North Bergen
WELTMER, WILLIAM R., JR., Murray Hill
•WOLFE, DONALD B., Haddonfield

New York

BELENTEPE, YILMAZ C., Corning
BRADLEY, PAUL L., Scotia
CHAMBERS, ROBERT A., Corning
CHANG, I-CHEN, New York
•DEAGLE, LORENZO, Schenectady
GARLAND, RICHARD V., Wellsville
GEMMILL, HARRY P., JR., Tonawanda
HAGER, HAROLD S. B., Corning
KEPHART, RICHARD S., Wellsville
KEUPER, THOMAS A., Schenectady
KORT, CALVIN L., New York
•LAFRAMBOISE, GUY R., Vestal
•LANDSMAN, DONALD I., Great Neck
MENZIE, JOHN J., Yonkers
PATTON, DONALD K., New York
•PECORA, RALPH J., JR., Beacon
TAYLOR, WILLIAM G., Schenectady
TERRY, FRED M., Pelham Manor
•WEINSTEIN, JEROME H., Elmhurst

North Carolina

CRAIG, DONALD J., Acme

Ohio

BRADY, IVAN M., Columbus
BUCK, LUCIEN, Beaver Falls
CIESLINSKI, ERNEST A., Cleveland
CAMPBELL, THOMAS M., JR., Alliance
DRLIK, JOHN M., Mt. Vernon
HALLORAN, JAMES W., JR., Cincinnati
HEGGY, ROBERT F., Canton
HOECK, WILLIAM T., Kettering
JOYCE, CALVERT P., Columbus
LEE, CHING-WEN, Cleveland
•MAGRATH, HOWARD A., Dayton
POOVAYYA, MOOVERA K., Cleveland
•PYLE, FOREST B., Akron
SACKLEH, FRED J., Dayton
SANDAKER, JOHN H., Cincinnati
•SELBY, JOHN D., Cincinnati
ZUGEL, VICTOR A., Parma

Oklahoma

JENSEN, CARL O., Oklahoma City
MORGAN, AUSTIN, Bartlesville
•ZUMWALT, GLEN W., Stillwater

Pennsylvania

ANDERSON, JOHN W., Erie
BAGGEROER, FREDERICK W., Murrysville
BERTRAM, LEROY W., Norristown
BRIGHT, BENJAMIN F., Berwick
ENGDAHL, LEE F., York
ENGLISH, LLOYD L., Erie
ENNS, MARK K., Pittsburgh
FISCHER, JOHN, Williamsport
HARRINGTON, ROBERT J., Irvine
•HOOD, JOHN H., JR., Waterford
KEALEY, HARRY R., Philadelphia
KHAN, MOHAMMED P., Philadelphia
KINNECOM, PAUL G., Berwick
MAXWELL, JOSEPH R., Pittsburgh
MOWATT-LARSSEN, ROLF, Bloomsburg
PASCHALL, JOSEPH A., Levittown
STOUGH, ROBERT A., Jeannette
VAN BLARCOM, PETER P., Philadelphia
WATERHOUSE, CLARENCE, Allentown
WINTER, ROBERT D., Pittsburgh

Texas

•BARNS, LEWIS W., Borger
CORNELIUS, FRANK H., JR., Houston
GRAVLEY, WILTON, Carrolton
LOH, WELLINGTON H. T., Dallas
MASSIN, HYMAN D., Port Arthur
ROARK, JAMES T., Dallas
RUSSELL, JOHN A., San Antonio
WEBB, JOSEPH C., JR., Dallas

Virginia

•STENGARD, EDWIN O., Arlington
VERNA, JOHN R., Newport News

Washington

SWAIN, EDWIN O., Richland
LUNDEN, SIDNEY L., Spokane
WAGSTAFF, WILLIAM G., Spokane

Wisconsin

BERNHARDT, ROBERT A., Milwaukee
•ESSER, DONALD J., Wauwatosa
GOODE, LAWTON T., Milwaukee
HILL, LEON D., West Allis
KOCHHAR, ROSHAN L., Milwaukee
LOVEJOY, DAVID C., Milwaukee
•MARUSKA, GERALD F., Madison
•PIH, HUI, Milwaukee

Wyoming

RANDOLPH, RICHARD J., Cheyenne

Foreign

BALA SUBRAMANIAM, T. R., Jamshedpur, Bihar, India
CHATTERJEE, ROHINI M., Glasgow West, Scotland
CHATURVEDI, KRISHNA C., Bhopal, Madhya Pradesh, India
DEVAPRAGASAM, CHRISTOPHER S., Avadi, Madras, India
FRIED, PAUL, Owerri, Nigeria
JACKSON, ALAN K., Geneva, Switzerland
LUM, MUN, Willowdale, Ont., Canada
•MORALES, MARTIN J., Cabimas, Zulia, Venezuela
•VAUGHAN, LEWIS W., Scarborough, Ont., Canada
VATES, JAMES E. D., Hamilton, Ont., Canada.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee. Upon receipt of your application a copy of our placement-fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application.

NEW YORK
8 West 40 St.

CHICAGO
29 East Madison St.

SAN FRANCISCO
57 Post St.

Men Available[1]

Chicago Office

Mechanical Engineer, design chemical-process-plant layout and installation, BSME; 49; five years' experience plant mechanical project engineer layout and installation; nine years machine design, petroleum lab, research, lubrication. $7500. Midwest. Me-2087-Chicago.

Junior Mechanical Engineer, BSME; 26; 16 months' experience in design department of rubber manufacturer; ten months machine-design group remaining in heating, ventilating, piping, and air-conditioning group. $6840. Immaterial. Me-2088-Chicago.

Administrative Engineer, BSME, PE; 33, single. Ten years with same petrochemical company in design, maintenance, and power; any field. Passport, will travel. $12,000. Me-2089-Chicago.

Design or Manufacturing Engineer, MSME; 24; 1½ years' experience—one year general training in manufacturing methods; six months' work experience in design. On student visa. $550 mo. Any location. Me-2091-Chicago.

Development Engineer, BSME; 27; four years' experience in design, product development, and experimental projects concerned with internal-combustion engines and related components. Minimum $8700. Midwest. Me-2092-Chicago.

Plant Engineer or Staff Maintenance Engineer, BSME, Marquette 1951; 33; 12 years professional engineer; production foreman, consulting engineer; maintenance foreman; assistant plant engineer; all phases of plant engineering, maintenance, and construction. Desires growth position, metal, or food-process industry. $10,000, plus usual benefits. Central or northern Wis., Minn., Mich., Southwest, Northwest, or New England. Me-2093.

[1] All men listed hold some form of ASME membership.

New York Office

Director or Manager of Engineering, Mechanical, Electrical, and Aeronautical Engineer. Directed product development in automotive, home appliance, aviation controls, industrial hydraulic power-equipment fields, for a period of 21 years resulting in patented, highway-profitable product lines for four national manufacturers. $22,500 minimum. Any location. ME-916.

Manager of Product Engineer, ME. Successful management of engineering department responsible for product development of rotary and reciprocating compressors, air-conditioning, and refrigeration components and assemblies, vending machines, air tools, portable compressors, advanced product designs for ground-support missiles, planes. $15,000. N.Y.C. or Northern N. J. ME-917.

Vice-President or Manager—Engineering or Operations, BSEE, MSME. Directly responsible for major profit increases; broad administrative experience in operations, engineering, research, and development; highly creative holder of many patents; exceptional ability to direct scientific and engineering personnel. $25,000. Any location. ME-918.

Engineering Services Supervisor, BSME. Six years (three supervisory) controlling standards for purchased materials and components, establishing operating practices and operating engineering library and publications group with engineering-oriented instruments/controls manufacturer. $12,000. Any location. ME-919.

Sales Engineer, educated Pratt Institute; 12 years sales and management with sales and service organization in mechanical equipment; 13 years mechanical project and design engineer with consulting-engineering firms in steam-power plants. $12,000. East. ME-920.

Plant Engineer, BSME, PE. Experience in

plant engineering, for research and industrial organizations. Maintenance and construction supervision, mechanical design, alterations to buildings and equipment, preparation of budgets. $9600. N.J., Pa., N.Y. ME-921.

Sales Reinforcement Engineer, BSME. Currently working in acoustical development, with position in automotive, mechanisms, electromechanical, or similar fields; sales reinforcement and/or trouble shooting for customer. $7200. Prefer East. ME-922.

General or Engineering Management or Staff BSEE. Eight years in engineering and general management of nationally known instrument manufacturer. Managed 50-man engineering department in company research and product design. $18,000–$20,000. East Coast. ME-923.

Management Trainee, BME, MBA, 25. Three summers engineering experience. Desires position in production control, product development, financial or cost analysis, or other staff position where technical background can be utilized. $6000 plus. N.Y. area. ME-924

Positions Available

Chicago Office

Senior Design Engineer, 29–50, preferably ME graduate, background in designing automatic machines. Must have some background in electrical component manufacturing field; e.g., resistors, capacitors, or semiconductors. Require five years' diverse experience in machine design. Must have held responsible position in machine-design layout, etc., for at least two years. Must be able to make good appearance in calling on customers occasionally. Must be able to express self clearly and be able to present well-organized and brief proposals which have been prepared to solve customer's production problems. Applicant must do creative thinking in submitting original designs of automatic production equipment for manufacture and testing of resistors, capacitors, and semiconductor components. $8500–$12,000. Employer will negotiate fee. Pa. C-8515.

Project Engineer, Research and Development, graduate mechanical, to 35; at least three years' experience in research and machine design, research and development. Must have a flair for machine design and "gadgeteering." Research department newly created and opportunity to become assistant chief engineer to section manager. Company manufactures hardboard and building materials. $7200–$9600. Employer will negotiate fee. Northwest Chicago suburb. C-8506.

Machine Designer, graduate mechanical, 28–35; at least two years' experience in design preferably liquid-solid separation equipment. Company manufactures centrifugals used in chemical, pharmaceutical, textile, petroleum, and beverage industries, all custom designed. Good potential to assume administrative position shortly. $7200–$8500. Employer will pay fee. Ill. C-8495.

Design-Development Engineers, graduate mechanical, 30–40; at least five years' experience in design and development on compressors, engines, and pneumatic or hydraulic equipment. Should have ability and potential to work into position of senior designer or chief engineer for a manufacturer of compressors and engines. $8400–$9600, depending upon experience. Employer will pay fee. Ohio. C-8490.

Advertising Account Executive, Public Relations, BSEE, ChE, ME, to plan and execute public-relations programs for engineering-oriented client firms, including writing general and technical news releases, technical papers, feature articles. Supervise press tours, customer house organs. Maintain active liaison with client management and engineers and with technical magazine editors, for a public-relations agency. $7500–$15,000. Employer will pay fee. Chicago, Ill. C-8480.

Project Engineer, graduate mechanical, for product development on vending machines and automotive parts and accessories. Must have creative ability, be a leader, and have aggressive personality and ability to work with others. Strong experience in tooling with emphasis on die casting, stamping, and draw dies. Opportunity to become chief engineer. About $12,000, plus bonus and stock option. Employer will pay fee. Mich. C-8477.

Design and Stress-Analysis Engineers, BSME, 28–35, at least five years' experience in design, stress analysis, and/or experimental stress analysis of heavy duty machinery or structures under impact desirable. One position involves design of new railroad-freight cars and related equipment under associate research and development director; other is on stress analysis for building freight

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NATURE OF WORK DONE

NAME OF EMPLOYER (Give name in full)

Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER, e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐

HOME ADDRESS | City | Zone | State

☐

PRIOR HOME ADDRESS | City | Zone | State

* CHECK "FOR MAIL" ADDRESS

I subscribe to

Address changes effective when received prior to:

☐ MECHANICAL ENGINEERING	10th of preceding month
☐ *Journal of Engineering for Power*	20th of preceding month
☐ *Journal of Engineering for Industry*	
☐ *Journal of Heat Transfer*	
☐ *Journal of Basic Engineering*	
☐ *Journal of Applied Mechanics*	
☐ *Applied Mechanics Reviews*	1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ U—Maintenance and Plant Engineering
☐ D—Materials Handling	☐ M—Production Engineering	☐ V—Gas Turbine Power
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ W—Wood Industries
☐ F—Fuels	☐ O—Lubrication	☐ Y—Rubber and Plastics
☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	
☐ I—Human Factors Group	☐ R—Railroad	

cars and related equipment, under direction of associate research and development director. Potential for advancement. Citizenship required. $615–$1110 a month, depending upon experience. Calumet, Ill., area. C-8471.

Plant Maintenance Engineer, graduate mechanical, 35–50, to take charge of all maintenance activities—maintenance foreman and crew, machine shop, electricians, refrigeration, clerical workers, 35 people, for a food-processing industry. $10,000–$13,000. Employer will negotiate fee. Chicago, Ill. C-8461.

Plant-Maintenance Engineer, graduate mechanical, civil, or electrical, to 45, to inaugurate at office level a maintenance program for multiplant operations involving budget maintenance, preventive maintenance programs, etc., for process industry. Will be indoctrinated in company's policy for about two years in Chicago then assigned to a district as area maintenance supervisor. Must have good personality. $9,000–$13,000, depending upon experience. Employer will negotiate fee. Chicago, Ill. C-8356.

New York Office

Engineers. (*a*) Merchant bar roller capable of designing rolls, setting up mills, and guides on small merchant bar mill, to be able to obtain section quickly. Should know production standards, be able to improve yields and perhaps develop new products. $14,000–$16,000. (*b*) Wire drawing plant operator, knowledge of all phases of wire drawing both fine and large carbon steels. Must know making of barbed wire and fencing, along with the galvanizing operations concerned in making galvanized wire; know equipment, dies, and drawing compounds. $14,000–$16,000. (*c*) General plant maintenance superintendent capable of taking full charge of maintenance in a fully integrated steel plant with blast furnace, coke ovens, electric furnace, Bessemer furnaces, structural, bar and sheet rolling; know machine-shop operations and spare parts inventory. $18,000–$20,000. South America. F-38.

Divisional Superintendent of Rolling for steel plant with blooming mill, billet mill, merchant bar mill, plate mill, reversing hot strip mill, tandem cold mill, temper mill, and all related facilities. Must have good cold and hot strip mill background, blooming, and bar mill experience secondary. Must be able to improve production, quality, and yields all units. $30,000–$35,000. South America. F-36.

Engineers experienced in mechanical-optical equipment, small items. (*a*) Senior development engineer, graduate mechanical, minimum of ten years' experience developing and supervising development of precision mechanical, electromechanical, or mechanical-optical equipment, to create, invent, or develop new small products of a complex mechanical or mechanical-optical nature. $9,000–$15,000. (*b*) Development engineer, graduate mechanical, minimum of five years' experience as afore-mentioned. $7000–$12,000. (*c*) Associate development engineer, graduate mechanical, minimum of two years' experience as afore-mentioned. $6000–$10,000. (*d*) Engineering designer, mechanical, experience preferably in the fields of high-speed mechanisms, servo controls, precision instrumentation, microfilm equipment or high-speed paper-handling equipment, to design complex mechanical equipment. $5000–$9000. New York, N. Y. W-35.

Mechanical-Stress Specialist, MS degree preferred, six years' experience, able to handle design and analysis of pressure vessels, turbines, small hi-speed machinery, gear boxes, or actuators. Will work with younger engineers to help train. Midwest. W-24(*a*).

Sales Engineer, young, mechanical engineering training and sales experience in instrument or precision-product fields in Metropolitan New York area and lower Conn. $7500–$8000. W-14.

Chief Engineer, mechanical design, product improvement, and cost-reduction experience for small manufacturer of laundry equipment. Minn. W-13.

Project-Development Engineer, 28–36, graduate chemical or mechanical, five to ten years' experience in process development particularly as applied to packaging industry. Must have knowledge of hot melt coating or waxing. $10,000–$13,000. Some local travel. New York, N. Y. W-8.

Manufacturing Manager, graduate mechanical, for plant (700–1000 employees) manufacturing electromechanical hydraulic precision instruments for aviation company. $18,000–$20,000. Northern N. J. W-5.

General Manager, graduate, ten years' experience with operational story of growth in the management of electronic and electromechanical manufacturing. $30,000–$40,000. Long Island, N. Y. W-1.

Engineers. (*a*) Proposal engineer, 23–28, graduate mechanical or chemical, three to five years' experience in engineering sales functions, to assist line sales engineers by performing all staff sales and sales administrative work required in the preparation of sales proposals to customers. $6600–$8400. (*b*) District representative, 28–35, graduate chemical or mechanical, advanced business degree desirable. Will have complete district responsibility for the sale and promotion of the products and services of a division, including low-temperature plants and equipment, engineering services and special cryogenic equipment. $9900–$12,000. Company pays interviewing expenses and placement fees. Pa. W-9997.

Additional listings of positions and men available are maintained in the offices of E.S.P.S. Direct inquiries to nearest office. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

Manager, Product Engineering, 30–40, preferably graduate mechanical, practical engineering experience on design and prototype manufacturing with thorough background in machinery design. Will be responsible for layout, design, prototype manufacture, cost reduction, and quality improvement for newly developed products involving miniature hi-speed rotating and reciprocating machinery. $12,000–$15,000. Company pays interviewing expenses and placement fees. Pa. W-9996(*a*).

Recent Graduate Engineers, mechanical, electrical, chemical, or civil, interested in fire-protection engineering work for insurance companies. Will consult with industrial companies, inspect industrial plants, and report recommendations. Training period; opportunity. Travel within metropolitan area only. $6500, to start. New York, N. Y. W-9994.

Senior Engineer, graduate mechanical, or originate new product designs or improvements to meet targets in product performance and costs for company manufacturing expansion joints, couplings, clamps, for piping. $10,000–$13,000. Pa. W-9991.

Product Development Sales Engineer, graduate mechanical, experience in metal fasteners and pole-line hardware. Will contact consumers and company distributors on new product programs and applications. $10,000, plus or minus. Northern N. J. W-9990.

Design Engineers, mechanical graduates or naval architects, with experience in design of marine-propulsion equipment, to be responsible for design, production, and test of engine-driven pumps and controls for jet propulsion of small boats. About $12,000. Fee negotiable. Midwest. W-9979.

Engineers. (*a*) Factory engineers, graduate mechanical, experienced in process engineering, fabrication, tool maintenance, for maintenance of equipment, trouble shooting, process control. (*b*) Project engineers, graduate mechanical or metallurgical, five years' engineering experience, preferably with company in the nuclear business, for customer order development. Pa. W-9972.

Machine Designer, 30–45, experienced in the design of automatic machinery. Experience with high-speed paper-converting machinery most desirable. Should be accustomed to carrying substantial responsibility in so far as execution of an approved design is concerned. Duties will include design and development of new types of automatic machinery for fabrication, filling, and handling of products and packages. Must work primarily on the board under supervision. $8000–$12,000. N. J. metropolitan area. W-9967.

Industrial Engineers, graduate industrial or electrical, three to five years' industrial-engineering staff experience, preferably in the manufacture of electronic components. Other experience in industrial engineering will be considered. $7000–$10,000. Company pays fees. N.Y. State. W-9962.

Engineers. (*a*) Maintenance engineer, graduate mechanical, experience in assisting chief plant engineer in planning and directing a complete buildings-equipment-maintenance program. Preparation of plans, estimates, and material requirements for construction projects, heating, ventilating, plumbing, and electrical systems. Liaison with supervisors of skilled craftsmen. Responsible for internal security, safety, and housekeeping programs. $8000–$10,000; excellent fringe benefits. (*b*) Plant-maintenance engineering assistant. $6500–$7500. Southeast. W-9955.

Assistant Sales Manager, graduate mechanical engineer, at least five years' field sales experience in air conditioning. Must be familiar with air distribution. About 50 per cent of time traveling throughout U.S.A. $10,000–$12,000. Conn. W-9954.

OBITUARIES

Thomas Theodore Andromidas (1916–1960), mechanical engineer, Ebasco Services, Inc., New York, N. Y., died, Oct. 12, 1960. Born, New York City, Jan. 18, 1916. Parents, Theodore and Despo Andromidas. Education, BME, New York Univ., 1942. Married Josephine Kuzbiel, 1945; one son, Craig. A specialist in piping and controls, Mr. Andromidas took his first position in the field with the General Chemical Company, Camden, N. J. He worked as a design engineer on various types of piping systems, including process gas lines, sulfuric acid lines, and sewage systems. Leaving the company in March, 1943, he was briefly associated with the Federal Telephone and Telegraph Company, New York, N. Y., where he designed a speed reducing unit that was used in conjunction with a directional antenna for the Signal Corps., U. S. Army. Then he went to work as a mechanical engineer with the Kellex Corp., designers and supervisors of the isotope-separation-plant construction at Oak Ridge, Tenn. He developed the engineering flow sheets for the process plant, and sized and ordered all pipe used in the process area. From 1945 to 1953, he was a senior designer with United Engineers and Constructors, Inc., of Philadelpha, Pa., working on the design and layout of power-plant piping and equipment. He went with Ebasco Service Inc., in 1953. Assoc. Mem. ASME, 1942; Mem. ASME, 1948. He was a registered professional engineer in Pennsylvania.

Raymond Leonard Barton (1885–1960), patent attorney, Los Angeles, Calif., died, Nov. 22, 1960. Born, Worthington, Ind., April 1, 1885. Education, BS(ME), Purdue Univ., 1909; ME, 1915. Mr. Barton was in private practice as a patent attorney in the U. S. and Canada since 1928. He himself held several patents for mechanical and architectural designs. He began his career in 1909 with Laclede-Christy, St. Louis, Mo., where he was an erecting engineer on plant installation. Some of the large projects on which he worked included the Federal Plate Glass Co. in Ottawa, Ill., and the Topeka Edison Co., in Topeka, Kan. He had similar responsibilities with the American Ship Windlass Co., in Providence, R. I., where he was in charge of installations for the Citizens Electric and Power Plant, Dayton, Ohio, among others. He also held positions with the American Car and Foundry Co., St. Charles, Mo., from 1910 to 1921, with the exception of a short period as a construction engineer and military observer in the U. S. Army. He was an instructor in trench warfare and small arms at the Aberdeen Ordnance Training School in Washington during its inception. He entered the patent field during the period, 1921–1928, as the head of Raymond L. Barton Drafting Co., Los Angeles, Calif., specializing in mechanical and architectual designs. Mem. ASME, 1948.

Warren Emery Blizard (1923–1960?), instructor in mechanical engineering, North Carolina State College, Raleigh, N. C., died recently according to a notice received by the Society. Born, Chattanooga, Tenn., Sept. 2, 1923. Education, BME, North Carolina State College, 1954. Before becoming an instructor at North Carolina State, Mr. Blizard was a field supervisor on turbine installation with the General Electric Co., in Charlotte, N. C. Assoc. Mem. ASME, 1954.

Norman Gourlay Brace (1894–1960), marine engineer, Bureau of Ships, Dept. of the Navy, Washington, D. C., died, June 14, 1960. Born, Victor, N. Y., May 5, 1894. Education, ME, Syracuse Univ., 1918. Mr. Brace was in officers training as a member of the Signal Corps, U. S.

Army, after graduation, and then went to work for Westinghouse Electric and Mfg. Co., in the stoker-engineering department. Later, he was a stoker engineer in the Philadelphia, Pa., sales office. Assoc.-Mem. ASME, 1924; Mem. ASME, 1935. He was a member of the ASME Old Guard Committee. His wife, Martha, survives.

Edwin Hardy Buford (1887–1960), retired engineer, St. Louis, Mo., died, Oct. 15, 1960. Born, Nashville, Tenn., Sept. 18, 1887. Parents, Joseph S. and Imogene Virginia (Hardy) Buford. Education, BE, Vanderbilt Univ., Nashville, Tenn., 1910. Married Ella Mae Jenkins, 1916; two sons, Edwin H., Jr., and Andrew J. Buford. Mr. Buford spent 40 continuous years in the employ of the Monsanto Chemical Company, St. Louis, Mo., and associated companies. He started there in 1915 as an engineer on the design and erection of special machinery for manufacturing fine chemicals. He became assistant chief engineer in 1918, and chief engineer in 1920. From 1924 to 1939, he was chief engineer of the Swan Chemical Company, a firm taken over by Monsanto in 1935. Thereafter, he directed the activities of the phosphate division of Monsanto, later becoming manager of the design section of the company's general engineering department. He retired in 1954. He held patents for a system of automobile ventilation and a method for making phosphorus. Mem. ASME, 1939. He was a registered professional engineer in the states of Alabama, Missouri, Illinois, and Texas.

Daniel Dresden (1886–1960), president, National Industrial Research Council, Delft, The Netherlands, died, Nov. 10, 1960. Born, Amsterdam, Holland, Jan. 20, 1886. Parents, Marcus and Anna (Myerson) Dresden. Education, ME, Technical Academy, Delft, 1910. Married Mimi Strelitskie, 1910; children, Daniel, Anton, Mimi, and Eline. A specialist in steam turbines, centrifugal pumps, and the theory of machine-tool design, Mr. Dresden was appointed professor of mechanical engineering in machine tools at the Technical Academy of Delft in 1920. He had previously spent a decade engaged in industrial design. For most of that period he was associated with Stork Brothers of Hengelo, Holland, first as a designing engineer, then as chief designing engineer, and finally as a general consulting engineer. From 1920 to 1928, the years of his professorship, he also was a consulting engineer for several firms in Holland and Germany, including the municipal electricity works of Amsterdam. He was the originator and editor of the monthly Netherlands foundry paper, *de Gietery*. In 1928, he left the academy to take a position as president of the Jaffa Engine Works in Utrecht, an activity that was halted in 1940 by German occupation. He spent the next five years in German concentration camps. He returned to his former position at the Technical Academy in 1945, but resigned the post in 1951, continuing thereafter as chairman of the National Council for Industrial Research, The Hague, a position he had held since 1946. He authored many technical articles. He was an officer of the Belgian Order of the Crown, 1936. Mem. ASME, 1928. He was a member of the Royal Institution of Engineers and the American Foundrymens Association.

Clive L. Edwards (1897–1960), electrical engineer, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., died, Nov. 8, 1960. Born, Knoxville, Iowa, Feb. 13, 1897. Parents, Mr. and Mrs. Harrison M. Edwards. Education, BS, Washington State Univ., 1930. Married Lottie E. Beck, 1919. Directly after graduating, Mr. Edwards took a position with the Atmospheric Nitrogen Corp., Hopewell, Va., where he was a student operator in a synthetic ammonia plant. The firm became the Solvay Process Corporation in 1931, and Mr. Edwards rose to operating engineer in the gas-production department, a position that placed him in charge of hydraulic and electrical equipment involved in manufacturing water gas. In the years before his entrance into the university, he held a series of positions in automobile sales and service in Yakima, Wash. At his death, he had been with the du Pont Company for several years. Assoc.-Mem. ASME, 1930; Mem. ASME, 1935.

Salvatore Follari (1901-1960?), designing engineer, formerly with Chemtex, Inc., New York, N. Y., died recently according to a notice received by the Society. Born, Palermo, Italy, Aug. 11, 1901. Education, ME, Istituto Nautico Superiore Palermo, 1922; attended Yale Univ. Mr. Follari came to the United States in 1935 after having spent several years employed by organizations in Italy. Arriving in this country, he went to work for the WPA in the Department of Parks, New York City, surveying property lines and drafting maps. Thereafter, he held mechanical drafting positions with several companies in New York and Connecticut, and then, during 1945–1946, worked on his own as a consulting engineer in New Haven. From 1946 to 1957, he held various positions as a piping and mechanical designer, working on gas and steam engines and boilers. He authored the article "Physical Properties of the Atom," published in 1948. Assoc. Mem. ASME, 1958.

Armand Theophane Gaudreau (1897–1960?), director, Gaudreau Associates, Westport, Conn., died recently according to a notice received by the Society. Born, Brunswick, Maine, July 8, 1897. Parents, Hector and Mary C. Gaudreau. Education, AB, Univ. of Maine, 1921; MBA, New York Univ., 1928. Married Isabelle deBouthillier Chavigny. Mr. Gaudreau received his education in electrical engineering, economics, and management, and used his knowledge to improve the profits and organization of a number of companies with whom he was associated from 1922 to 1943. Chief among these was The Barrett Co., New York, N. Y., a division of the Allied Chemical and Dye Corp.; and the Westinghouse Electric and Mfg. Co., Pittsburgh, Pa. With the former company for 17 years, he developed cost-accounting procedures that were placed in use throughout the organization's 35 plants, and reorganized its clerical forces. Joining Westinghouse in 1940, he worked toward modernizing its plant layout and management. In 1944, he joined the consulting engineering firm of Stevenson, Jordan and Harrison, Inc., management engineers of New York City, and five years later, assisted in forming Gaudreau, Rimbach and Associates, in Pittsburgh. Later, he became president of the firm, then Gaudreau Associates. He was a lecturer at the University of Pittsburgh from 1951 to 1956. He was co-author of a 400-page engineering text, "Plant Layout, Principles and Practice," published in 1951, and author of more that 50 articles on material handling, plant layout, and industrial engineering published in technical journals. Mem. ASME, 1949. Member also, Delta Phi Epsilon, American Material Handling Society, and the American Statistical Association.

Maxwell Gibbs (1892–1960), owner, The Maxwell Gibbs Co., Los Angeles, Calif., died, Oct. 12, 1960. Born, New York, N. Y., Dec. 4, 1892. Parents, George and Rose Gibbs. Education, BSCE, Cooper Union Institute of Technology, 1914. Married, 1921; children, Grace Rita and Iris Marilyn. Mr. Gibbs was instrumental in forming the contracting-engineering partnership of Gibbs-Rice Co., in New York in 1925. While under contract for the city, the firm built the structures of the DeWitt Clinton High School, and public schools 132, 123, 86, and 94. The company became the Maxwell Gibbs Corp., in 1929 and, during the period ending in 1932, constructed the Kings County Hospital in New York. During the war, Mr. Gibbs was an associate mechanical engineer with the Department of Plant Operations, spending some time in Honolulu, Hawaii. During the early part of his career, he worked with several engineering companies, spending a period as assistant engineer in construction of sections of the Seventh Avenue subway in New York. Mem. ASME, 1944. He was a member of the American Society of Military Engineers, ASCE, the Chinese Institute of Engineers, the Engineering Institute of Canada, the American Society of Industrial Engineers, and the Army Ordnance Association. He was a registered professional engineer in New York State.

Charles Ralph Gifford (1886–1960?), sales engineer, Highland Park, Mich., died recently according to a notice received by the Society. Born, Bay City, Mich., July 1, 1886. Education, BS, Michigan State College, 1912. Mr. Gifford spent a year with the Illinois Steel Co., Gary, Ind., following graduation. Then, after a few years as a draftsman with the Buick Motor Co., Flint, Mich., and a period in charge of construction for The Davison Telephone Co., Davison, Mich., he went into power-plant engineering. He entered the research and production department of The Detroit Edison Co., Detroit Mich., in 1916, taking responsible charge of tests on boilers, turbine condensers, and similar equipment. During his last six months with the company, he was technical engineer of the Connors Creek Plant. In 1918, he entered the service of the U. S. Fuel Administration as an assistant administrative engineer for Michigan, and in that capacity had charge of classifying all boiler plants in the state, and distributing coal to them. Several months later, he joined Smith, Hinchman and Grylls, of Detroit, leaving them soon after to spend time with two other companies, and returning there in 1922. In the interim he was with the Moline-Rock Island Mfg. Co., Moline, Ill., as a technical engineer, and The Arnold Co., Chicago, in charge of the design and construction of boiler plants for new engine terminals of the Pere Marquette Railroad. With Smith, Hinchman and Grylls he directed the design of several power plants, including the Detroit Municipal Power Plant. Before his death he worked as a sales engineer. Mem. ASME, 1926. He was a member of the Detroit Engineering Society.

Frank Gatfield Hobart (1864–1960), retired consulting engineer, died, Oct. 2, 1960. Born, Oak Creek, Wis., Jan. 31, 1864. Parents, Adin and Clarissa (Beckwith) Hobart. Education, BSME, Univ. of Wisconsin, 1886; ME, 1888. Married Bertha C. Lewis. Married 2nd, Daisy M. Buckeridge, 1918; two children, Charles and Carolyn. Married 3rd, Ida Schaub, 1937. Mr. Hobart held drafting positions with several companies up until 1889, when he began a life-long relationship with The Williams Engine Works, of Beloit, Wis., which in 1893 was taken over by Fairbanks, Morse and Co. In 1889 with the expressed desire of making "high speed" engines a "life work," he joined The Williams Engine Works as chief draftsman. In 1891, this company built and installed the first steam engines used in electric-light plants in Chicago, and Mr. Hobart supervised the first installation, made on the site of the present Chicago Civic Opera House. In 1893, the Williams Engine Company was combined with the Eclipse Wind Engine Company under the name of Fairbanks, Morse and Company, and Mr. Hobart became its chief engineer. He helped to develop the first internal-combustion gas engine to be used in the United States. He became a consulting engineer for the company in 1929, and when he retired a few decades later, terminated a period of service with Fairbanks-Morse of close to 60 years. The University of Wisconsin cited him in 1950 for "notable development in gas and oil engines." He authored about 50 patents. Mem. ASME, 1890. Fellow ASME, 1941.

William Stevenson Hobbs (1902–1960), mechanical engineer, Sun Oil Co., Philadelphia, Pa., died, Nov. 26, 1960. Born, Miami, Fla., Sept. 2, 1902. Parents, William Alexander Hanson and Henrietta (Stevenson) Hobbs. Education, BS(ME), Carnegie Institute of Technology, 1926. Married Celia Mohney, 1926; children; Milton Mohney, Charlotte Mary, June Stevenson, and Laura Davis. A specialist in automatic heating, refrigerating, and air conditioning, Mr. Hobbs was employed at Sun Oil Company since 1928. He had held previous positions with the General Public Utilities Co., of Miami, Fla., as an operator, and with the Fay Sales Company, of Riverton, N. J., as a sales manager. He started with Sun Oil as a draftsman at the company's Marcus Hook Refinery. In 1942 he became a mechanical engineer in the manufacturing department, where he worked with special problems concerning boilers and heating equipment. He recommended and installed the first floor and ceiling heating equipment in his territory, later preparing a "Heating Design Manual" for company engineers interested in radiant-heating design. Since 1934, Mr. Hobbs consulted for his company and other organizations on special problems of cooling and heating, and especially on the design of floor and ceiling heating systems. He authored articles and technical data that were published in *Power*, *Heating, Piping and Air Conditioning*, and other journals. Assoc.-Mem. ASME, 1928; Mem. ASME, 1946. He was a member of ASHRAE, and a registered professional engineer in Pennsylvania.

Robert J. Hoffman (1887–1959), retired as vice-president of the Union Carbide Corp., New York, N. Y., died, Jan. 24, 1959. Born, Cincinnati, Ohio, June 4, 1887. Education, AB, Armour Institute, 1906; BS, 1910. When Mr. Hoffman retired from the Union Carbide Corp., in 1952, he had been with the company and its subsidiaries for nearly 40 years. He joined the Linde Company, a subsidiary then known as the Linde Air Products Co., in 1914. By 1918, he was general superintendent of plants of that company and The Prest-O-Lite Co., Inc., also a subsidiary. For the former organization at that time, he supervised the research laboratory, 28 oxygen plants, and several shops, while also supervising the operation of 25 acetylene plants of the latter company. At the time of his retirement, he was vice-president in charge of industrial relations for the entire corporation. Mem. ASME, 1920.

Walter Radcliffe Hope (1874–1960), retired project engineer, formerly with E. I. du Pont de Nemours & Co., Wilmington, Del., died, Oct. 27, 1960. Born, Wilmington, July 25, 1874. Parents, William Radcliff and Anna Mary Hope. Education, high school. Married Elenthera Virginia Porter, 1898; children, James Aubrey and Anna Elizabeth. Mr. Hope retired from the du Pont Co. in 1941, after 37 years of service, 22 of them as project engineer in charge of factory design. He joined the company in 1904, after a two-year partnership with another engineer had dissolved. Mr. Hope took his first job in 1891 as a clerk with the Diamond State Iron Co., in Wilmington. He served an apprenticeship there, and then worked for various concerns on miscellaneous machine design. He specialized in machine design throughout most of his career. He held several patents. Assoc-Mem. ASME, 1915; Mem. ASME, 1922. He was a member of the New York State Society of Professional Engineers and NSPE, and was a registered professional engineer in the states of New York, Virginia, Delaware, and Tennesee.

Lewis F. Lyne, Jr. (1892–1960), of the U. S. Defense Department, Fort Monmouth, N. J., died, Nov. 25, 1960. Born, Jersey City, N. J., Sept. 4, 1892. Parents, Mr. and Mrs. Lewis F. Lyne. Education, ME, Bucknell Univ., 1914. Mr. Lyne, whose father was a founding member of ASME, worked in the field of lubrication and process oils. In 1915, after spending a few years drafting and designing with the Tide Water Oil Co., at their Bayonne, N. J., refinery, he was able to organize his own company, the Oil Specialties and Supply Co., in New York City. The organization acted as a jobber of petroleum products and mechanical equipment. Mr. Lyne

did general consulting work until 1917, when he was commissioned a 1st Lieutenant in the ordnance inspection section of the U. S. Army. At the end of his term of service in 1919, he continued with his company, originating and developing "Rustavoid," a product used as a slushing compound for the prevention of rust on metal surfaces. Transferring his interest to the utilities in 1925, he became supervisor of gas, electric, and water utility properties for the General Engineering and Management Corp., New York. Several years later, after having held positions with a number of companies, including the Public Utility Commission, in New Jersey, he became a government project supervisor and assistant to the utility officer at Fort Monmouth, N. J. He also taught at the National Defense Machine Shop School. In 1942, he became an administrative officer of the Signal Corps, Camp Evans, N. J., with duties to design and equip electronic laboratories; and was assistant to the commanding officer of the Signal Corps Officers School at Asbury Park, N. J. Later, as a member of the Air Service Command, he was stationed first in Ohio, then at the High Frequency Experimental Station, Allenhurst, N. J. During the war, he also was a technical representative for the Alien Property Custodian in New York, later acted as a co-ordinator between the Reconstruction Finance Corp., and the owning agencies, and then worked with the War Assets Administration. He authored some articles on petroleum products for technical publications and college texts, and wrote and edited instruction books on mobile radar equipment for the Signal Corps. Mem. ASME, 1945. He was active in the ASME Metropolitan Section, and was chairman of the Metropolitan Section of the Petroleum Division in 1925. Mr. Lyne donated his father's membership certificate and pin to the Society at its 75th Anniversary in 1955. These hang as mementos of this founding member at ASME headquarters in the Engineering Societies Building in New York. Member also, ASTM; and honorary member, National Association of Stationary Engineers. He was a registered professional engineer in New Jersey.

Robert Dawes Madeira (1917–1960), consulting engineer, Profit Counselors, Inc., New York, N. Y., died, Fort Lauderdale, Fla., June 23, 1960. Born, Atlantic City, N. J., March 29, 1917. Education, attended New York Univ. A specialist in chemical plant piping and instrumentation, Mr. Madeira began his career as a pipe designer with the American Cyanamid Co., New York. He continued in this work with a series of oil and chemical companies, among them the Celanese Corporation of America, and Foster Wheeler Corp., New York; Atmospheric Nitrogen Corp., Hopewell, Va.; and Lever Brothers Co., Edgewater, N. J. He rejoined the Celanese Corp. in 1948, holding a series of administrative positions until 1956, when he went with Charlotte Engineers, Inc., architects and engineers of Charlotte, N. C. He became president of the firm, in charge of operation and design for commercial, industrial, and governmental installations. He joined Profit Counselors Inc., in 1959, and was working out of the Florida office at the time of his death. Mem. ASME, 1958. Member also, North Carolina Society of Engineers and the Charlotte Engineers Club.

Edward J. Paque (1884–1960), works manager, The National Supply Co., Cincinnati, Ohio, died, March 2, 1960. Born, Williamstown, Ky., August 25, 1884. Parents, John and Anna (Suttner) Paque. Education, high school. Married Martha E. Shard, 1923. Mr. Paque worked mostly as a designer and engineer of special machinery during the decade preceding 1915, and then became chief engineer with The Pollak Steel Co., Cincinnati. He was associated with that company for several decades, while also acting as a consultant for several other firms. He held more than a dozen U. S. patents, and some Canadian patents. Assoc-Mem. ASME, 1920; Mem. ASME, 1921. He was a registered professional engineer in Ohio.

Kenneth Redman (1889–1960), president, Redman Associates, Inc., High Point, N. C., died, Nov. 25, 1960. Born, Chelsea, Mass., Oct. 11, 1889. Education, attended Univ. of Washington. Mr. Redman received his education in forestry and chemistry, and applied his knowledge in the lumber industry, primarily in the seasoning and conditioning of wood. Starting as a treating engineer and chemist for the Pacific Creosoting Co., Seattle, Wash., he later became the superintendent of a subsidiary, the Vancouver Creosoting Co. In 1917, he was with the U. S. Bureau of Aircraft Production, in charge of aircraft lumber seasoning for the New York district, which extended from Maine to North Carolina. Several years later, after positions with the Sturtevant Aeroplane Co., Boston, Mass., and the Standard Dry Kiln Co., Indianapolis, Ind., he organized the Redman Engineering Service. The firm served the furniture industry through the design and sale of drying systems, also consulting on lumber conditioning and materials. For several years, he edited the "Dry Kiln Department" section of the *Hardwood Record*, a national trade paper in Chicago. Mem. ASME, 1948. Member also, Forest Products Research Society.

Anthony Joseph Scelba (1914–1960), assistant plant manager, Leslie Co., Lyndhurst, N. J., died, Oct. 17, 1960. Born, Clifton, N. J., Sept. 1, 1914. Parents, Luigi and Sebastiana Scelba. Education, ME, Villanova College, Villanova, Pa., 1941. Married Purissima Gaffney, 1942; children, James, Josephine, Ann, Joan, and Mary. Mr. Scelba was assistant plant manager for the Leslie Company since 1941. The company manufacturers regulators and controllers for pressure, temperature, and liquid level control. Jun. ASME, 1942. He was a member of the American Society of Tool Engineers and the New Jersey Society of Professional Engineers, and was a registered professional engineer in New Jersey.

Spencer Baldwin Terry (1887–1960), office assistant to the Secretary of Defense, died, Memorial Hospital, New York, Dec. 19, 1960. Born, Orient, L. I., N. Y., August 11, 1887. Education, ME, Pratt Institute of Science and Technology, 1909. Beginning in 1915, Colonel Terry spent 26 years with Pratt & Whitney in West Hartford, Conn., during which he worked as a gage engineer, and became chief engineer of the gage division. The experience gained there in the design and development of precision instruments and automatic gages led to his appointment in 1940 as technical advisor to the secretary of war. The appointment was the start of a long period in government service. From his position as a surveyor of gage requirements for the Army, Navy, and Air Corps., he rose to an administrative officer in the war department, where he supervised the procurement, control, and distribution of gages for all ordnance loading plants. He also supervised the establishment of gage checking units and the development of automatic equipment for ammunition loading lines. He was commanding officer of an ordnance plant, and spent 18 months as chief of the gage section in the Navy department. In 1945, he joined the Federal Machine and Welder Company, Warren, Ohio, becoming assistant to the president. Later, he joined the office staff of the secretary of defense. He authored several articles on gages, and held patents on precision instruments and on the continuous gaging of strip steel at high speeds. Mem. ASME, 1946. Surviving is his son, Spencer B. Terry, Jr.

Harry Collins Wight (1885–1960), consulting engineer, Waynesville, Ohio, died, March 23, 1960. Born, Dayton, Ohio, June 20, 1885. Parents, Harry Conover and Harriet (Campbell) Wight. Education, BS, Denison Univ., 1907, ME, Cornell Univ., 1909. Married Mildred Hanna, 1915; children, Collins IV and Allan Campbell Wight. A specialist in hydraulic and power engineering, Mr. Wight was for several years chief engineer and general superintendent of the Division of Water in Dayton, Ohio, with direct charge of improving and modernizing the city's water system. He held this position from 1914 to 1922, after which he spent a period as general manager of Lyndon Chemical Co., and then worked as a consulting engineer out of Dayton, later moving his office to Waynesville. He also acted as vice-president of the Dayton Lumber and Mfg. Co., for six years. He was manager of the Smaller War Plants Corp., to 1946. Assoc-Mem. ASME, 1917; Mem. ASME, 1919. He was a member of The Engineers' Club of Dayton, and was a registered professional engineer in Ohio.

Louis William Williams (1878–1960?), consulting engineer, Brookyln, N. Y., died recently according to a notice received by the Society. Born, Brooklyn, June 20, 1878. Parents, Louis William and Ella (Mangam) Williams. Education, attended Columbia Univ. Married Carolyn Snow, 1917; one daughter, Harriet. Mr. Williams spent his career in the steel industry. For ten years he was the eastern agent for Union Drawn Steel Co., Beaver Falls, Pa., which later became the Republic Steel Co. During the following years, he was associated with several steel companies, among them, Cauldwell Wingate Co., New York, as secretary in charge of sales; Bliss and Laughlin Inc., Harvey, Ill., as eastern manager; and Schrock and Squires Steel Corp., New York, as president. He knew buyers, consumers, and jobbers of steel in the territory bounded by Washington, D. C., Boston, and Buffalo, having traveled it intensively. He was a past director of the American Manufacturers Export Association. He also spent a period at the head of his own business in building management, maintenance, and real estate, in New York City, and later had his own consulting office on Broadway, from which he furnished metals and metal products to many industries. Mem. ASME, 1938. Committee service for the Society included work on the standardization of shafting as chairman of the Subcommittee on Tolerances, and work on the standardization of hot and cold finished carbon steel bars, representing the ASME at the American Standards Association. He was a member of AIME, SAE, ASTM, the American Electro-Chemical Society, and the American Iron and Steel Institute. He was a licensed professional engineer in New York State.

Bernard J. Wolfe (1898–1960), design engineer, Haloid Xerox, Inc., Rochester, N. Y., died, November 1960. Born, Bethlehem, Pa., Jan. 20, 1898. Parents, O. S. Wolfe and Martha (Mocken) Wolfe. Education, attended Mechanics Institute, Rochester, and the Univ. of Rochester; ME, Columbia Univ., 1933. Married Ruth McGuire, 1928. Married 2nd, Ruth H. Gagnier, 1936; one daughter, Joan. A designer of automatic machinery for a variety of industrial uses, Mr. Wolfe served his apprenticeship in instrument making, working with the Bausch and Lomb Optical Company on rangefinders, gunsights, microscopes, and scientific instruments. Spending the years from 1917 to 1920 as an experimental mechanic and model maker, he was employed by a number of concerns in Rochester, N. Y., working with devices for temperature measurement and electrical control, as well as recording instruments, office-appliance machinery, and radio apparatus. He also was a special designer of shoe and textile machinery for three years with the Booth Bros. Co., Rochester, a subsidiary of the United Shoe Machinery Corp., before going into private practice as a design engineer. The special machinery he designed at that time took him into the field of patent work, and eight years later, after a period inventing precision machine tools with Gleason Works, Rochester, he entered into four years of patent research and development for Rice Engineering Corp., in New York City. His work concerned textile machinery. In 1935, he rejoined the Bausch and Lomb Optical Co., where he had been an apprentice two decades before, this time to serve on the staff of the scientific bureau as a designer of optical, photographic, medical, and military instruments. Ten years later, continuing in the optical and photographic industry, he joined Eastman Kodak Co., but remained with them only four years before going with Haloid Xerox, Inc., in 1949, as an inventor of xerographic equipment. His work on automatic machinery utilizing the xerographic reproduction process helped to usher in a revolution in the concepts of storing, retrieving, and printing documentary information and engineering drawings. Mr. Wolfe contributed to several volumes of the work "Ingenious Mechanisms for Designers and Inventors," published by The Industrial Press, and wrote a large number of papers on subjects covering tolerances, estimating, and ingenious mechanisms. His papers brought him three awards. The first, in 1945, was the third prize in the first annual die casting awards sponsored by *Die Casting Magazine*. He received one of the 1946 Ingenious Mechanisms Awards sponsored by *Machinery;* and in 1959, received the $50,000 Machine Design Award for the James F. Lincoln Arc Welding Foundation for a paper on xerographic printing. He held a dozen patents on machine tools, optical projection, and xerographic cameras and printers. Assoc.-Mem ASME, 1925; Mem. ASME, 1935; Fellow ASME, 1960. Committee service in ASME included membership on the Executive Committee; chairmanship of the Papers Committee, 1947–1952, to review papers for presentation by the ASME Machine Design Division; and chairmanship of the Executive Committee of the ASME Machine Design Division, 1949–1951. He was the organizer and first chairman of the machine and product design group of the Rochester Section, and reporting representative of the ASME Machine Design Division for the 1953 Rochester Fall Meeting of ASME. He was chairman of the Honors and Awards Committee of the Rochester Section in 1955, and a member of its Executive Committee in 1959. He served on numerous occasions as chairman and vice-chairman at ASME Annual Meeting sessions. In 1960, he was appointed ASME representative on the ASA B-5 Sectional Committee on Standardization of Small Tools and Machine Tool Elements. Engineers Joint Council selected him in 1948 as one of its registered members to be called upon for technical advice in the event of a national emergency. During 1945–1946, he was a member of the ASA Z-14 group to study the British C. A. Gladman report on drafting standards and to set up an American, Canadian, and British drafting standard. He also was a member of the Photographic Society of America, the Rochester Engineering Society, and the New York State Society of Professional Engineers, and was a registered professional engineer in New York.

Frank Keyte Worsley (1896–1960), mechanical engineer, Brighton Terminal, Ltd., Brighton, Trinidad, B. W. I., died, May, 1960. Born, Worsley, England, March 25, 1896. Education, attended Salford Technical College. After serving an apprenticeship and working briefly for several firms in London, England, Mr. Worsley left that city in 1922 for Trinidad, and a position as a machine shop superintendent with Kern Trinidad Oilfields Ltd. Between 1922 and 1944, he also served the company as a field engineer and finally a chief engineer. Then he took a position as a field engineer with the National Mining Corp., Trinidad, remaining until 1950, when he joined Brighton Terminal, Ltd. There he became a mechanical and construction engineer, supervising plant erection and maintenance. Mem. ASME, 1953. He was a member of the Institution of Mechanical Engineers, and the Institute of Petroleum, and was a licensed boiler inspector for Trinidad and Tobago, B. W. I.

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD

YARWAY GUN-PAKT EXPANSION JOINTS ARE BEING SPECIFIED IN RECORD NUMBERS

These user-benefits tell why:

All over the country a rapidly-increasing number of expansion joint jobs on steam and high temperature water piping at utilities, industrial plants and institutions are being specified "YARWAY GUN-PAKT." Here's why:

TROUBLE-FREE SERVICE
Shutdowns are eliminated. Packing can be added *under full line pressure.* No vents. Joints never need repacking.

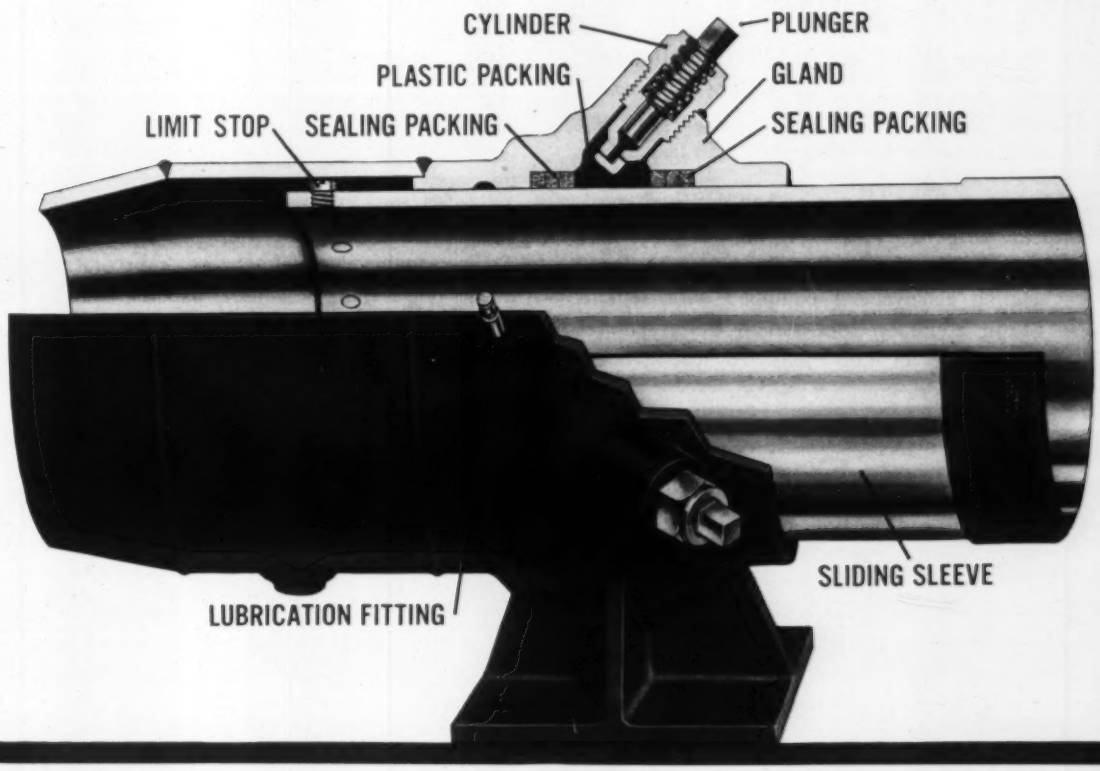
SIMPLIFIED DESIGN
Sectioned view (below) shows at a glance the simple, compact design. Provides easy accessibility, takes less space to install and maintain, needs smaller manholes, fewer joints per length of pipeline.

RUGGED DEPENDABILITY
All-steel construction, with durable, chromium-plated seamless steel sleeves. *No chance of metal fatigue.*

INTERNAL AND EXTERNAL GUIDES
Positive alignment of sleeve in stuffing box, *where it counts.*

MINIMUM MAINTENANCE
Never a shutdown for repacking—and records show an average of one manhour and 65 cents worth of packing added per joint per year. *Many Gun-Pakt Joints have been in service over 25 years with only this nominal maintenance.*

Why don't *you* investigate Yarway Gun-Pakt Joints by calling a Yarway Sales Engineer at one of the 20 Yarway offices located from coast-to-coast—or simply by writing for Bulletin EJ-1917.



Owner: METROPOLITAN FAIR AND EXPOSITION AUTHORITY, CHICAGO, ILL. *Chief Architect:* ALFRED SHAW OF SHAW, METZ AND ASSOCIATES.
Architectural Consultants: JOHN W. ROOT OF HOLABIRD & ROOT . . . VICTOR HOFFER . . . EDWARD STONE. *Consultant Mech. & Elec. Engineers:* JOHN DOLIO & ASSOCIATES.
General Contractor: GUST K. NEWBERG CONSTRUCTION CO. *Heating & Air Conditioning Contractor:* DELL CORPORATION.

Big As Six Football Fields

McCORMICK PLACE

Chicago's New $35,000,000 Exposition Center

JENKINS VALVES control lines in mammoth heating – air conditioning system

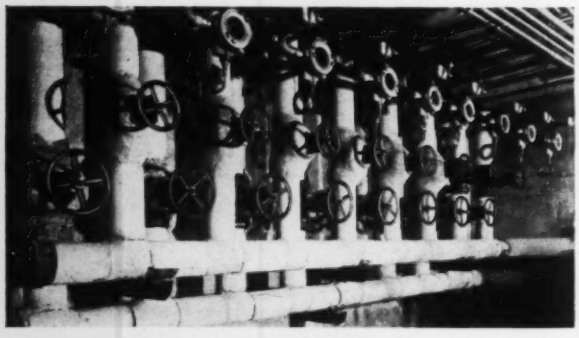
IT'S BIG, the main exhibit area is 320,000 square feet, almost free of pillars, with a 40-foot ceiling! The theater seats 5,000 people. Restaurant facilities can feed as many in an hour. Loading docks accommodate 50 trailers.

Volume-wise, this "first exposition hall designed specifically for the purpose" is almost as big as New York's Empire State Building . . . another famous architectural and engineering achievement equipped with Jenkins Valves. To air condition McCormick Place requires refrigeration capacity of 4,000 tons. To heat it, boiler capacity of 2,400 horsepower is needed.

A BIG JOB FOR VALVES is evident here. And, an opportunity to assure big savings with valves that ask for only minimum maintenance. The building experts responsible for McCormick Place called for Jenkins Valves to control the service lines in the mammoth complex of heating and air conditioning.

To keep your valve maintenance and replacement costs down, follow the lead of the experts. Specify *Jenkins* Valves. They *cost no more to buy* . . . and over the long, hard pull they cost considerably less. Jenkins Bros., 100 Park Avenue, New York 17.

SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE



Jenkins Valves control lines from eight 30,000 gal. oil tanks.

JENKINS

LOOK FOR THE JENKINS DIAMOND

VALVES

JENKINS SINCE 1864 Jenkins Bros

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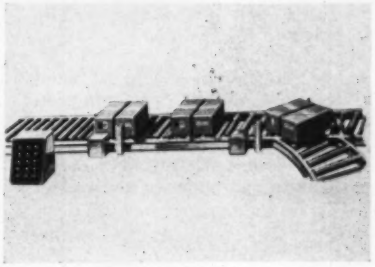
Available literature or information may be secured by using convenient Readers Service Card on Page 141

NEW EQUIPMENT



Conveyer Control System

Electronic Controls Div. of Flo-Tronics, Inc., has announced a new Mag-Pac magnetic control system claiming low installation cost with great flexibility in application. The Mag-Pac modular control units are said to open the way to full scale conveyer line automation for many small and medium size manufacturing, warehousing, and distributing firms. Mag-Pac control systems can be operated from a central dispatcher unit, or by remote punch card or tape command.

Principal units in the Mag-Pac system are the dispatcher, marker, tally, reader, and coordinator. An optional selector unit is provided where operators are intercepting particular items from the conveyer line as needed.

With the appropriate combination of these interchangeable basic control units, any conveyer system for packages, parts, units, or containers can be pre-set to automatically direct materials to selected stations, load or unload when ready, follow various routes, give priority and carry out many similar functions.

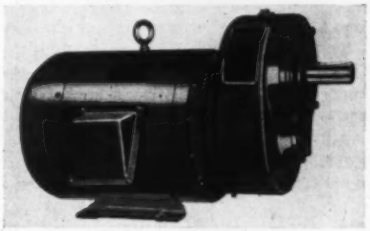
Specific conveyer system applications include order filling, product sorting, selecting from live storage, conveyer loading and unloading, transferring and diverting, and many others. Coded commands can be provided to activate any relays needed at the various stations to carry out the function desired.

Mag-Pac units can be installed on existing conveyer systems or new installations, in standard or custom models to meet varying requirements. —K-1

Air Sampler

The Gelman Instrument Co. offers its Hurricane Air Sampler, which was developed in order to sample a very large volume of air in a short period of time. When testing for some radioactive dusts and such highly toxic materials it would be impractical to sample any other way. The time necessary to collect samples is said to be reduced from days to hours or minutes.

Two models of the Hurricane Air Sampler are now available. The No. 16002 has a nominal capacity of 150 cfm and a $^3/_4$ hp universal motor. The Model No. 16003 has a sample capacity of 196 cfm at high speed and 150 cfm at low speed. This is a two-speed model, developing 1 hp at high speed and $^3/_4$ hp at low speed. —K-2



Gearmotors and Speed Reducers

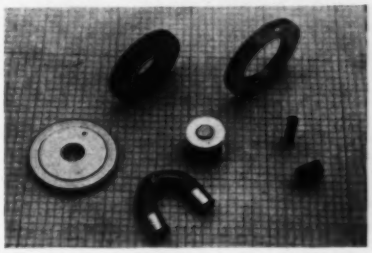
A six-page bulletin describing its full line of gearmotors and Line-O-Drive coupled speed reducers is announced by Howell Electric Motors Co.

Gearmotors range from 1 to 150 hp, a-c; single, double, and triple reduction; with speeds as low as 7.5 rpm. They are available in AGMA Classes I, II, and III; in open, enclosed and explosion-proof enclosures; with a wide variety of mountings; all NEMA standard start-run characteristics; either parallel shaft or right-angle drive (up to 30 hp).

Line-O-Drives described are from 1 to 75 hp, a-c, with output speeds as low as 1.2 rpm; either flange- or foot-mounted; open, enclosed and explosion-proof motors; standard NEMA starting torques.

In addition to descriptive and performance data, two full pages of selection tables tabulate various output speeds for each horsepower rating in all three AGMA classes.

The bulletin lists numerous typical applications but points out that uses are for any drive requiring "slower-than-motor" speeds. —K-3



Miniature Bellows

Precision instrument bellows and sensitive diaphragms are now available with the Ultraform Process, a manufacturing method announced by the Kinemotive Corp. The process is said to permit a wide selection of sizes, shapes and proprietary alloys.

Wall sections of 0.0005 to 0.005 in. are available in materials suitable for high temperature, high pressure, and non-magnetic applications.

In production by the Ultraform process are custom bellows assemblies for force balance, volumetric compensation, and motion applications. A complete custom design engineering service is available. —K-4

Self-Aligning Bearings

Smith Bearing Div., Accurate Bushing Co., offers its line of Smith align bearings as an answer to increasing demands of precision and durability on self-aligning bearings. All components are fully hardened and precision tooled. The unique, selfcontained two-piece Smith align ring construction is said to make possible the precision ground fit of the ball and ring.

A wide range of steels and special alloys are available. Bore diameters range from 0.1900 in. to 1.5000 in. —K-5

Die-Stamped Circuits

Die-stamped circuits that combine economy with reliability in mass-production applications have been announced by Dytronics, Inc., a subsidiary of Taylor Fibre Co.

The Dytronics circuits are made by die cutting the conductor pattern from metal foil coated on one side with a thermo-responsive adhesive and simultaneously bonding the circuit to the insulating base material under heat and pressure. Use of long-wearing embossing dies permits production runs of approximately four million circuit boards without die change and while maintaining tight tolerances on the circuit. —K-6

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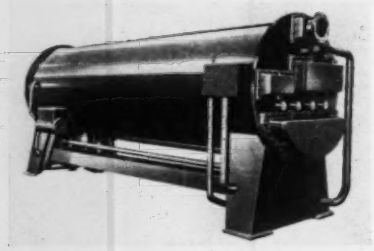


Absorption Coolers

Three new sizes of absorption "Cold Generators," in capacities of 400 tons, 455 tons and 530 tons, have been announced by The Trane Co. The new units expand the line to 12 basic sizes in the 100- to 530-ton range.

The three new sizes feature the same single-shell, hermetic design as the original nine sizes introduced in 1959. The single-shell arrangement reduces machine height, permitting installation in low-ceiling areas, the company said.

In addition, the company states, the absorption Cold Generator is completely automatic. —K-7

Cam Followers

Smith Bearing Div., Accurate Bushing Co., presents a line of cam rollers in two types, cam follower rollers and cam yoke rollers. All components of Smith cam followers and cam yoke rollers are made from carefully selected bearing quality steels, heat-treated. The inner-race stud members of Smith cam followers are provided with differential hardness, so that the raceway has full bearing quality hardness to provide resistance to wear, while the thread end is maintained in a softer condition to provide strength.—K-8

Portable Balancing Equipment

A precision, portable balancer has been introduced by Stewart-Warner Corp. It is designed for in-place balancing and vibration analysis. It is said to be ideal for eliminating vibration in grinding wheels and cutter heads. The Model 2390 portable balancer consists of a strobe and meter head, electronic unit, biration pickup, pickup extension cabel, tripod, electronic tubes, shoulder strap, and carrying case. It operates on 115 volt, 60 cycle, single-phase current. —K-9

Fiberglass Kinetic Isolation Pad

A new, efficient vibration isolation pad using specially processed, high-density fiberglass has been announced by Consolidated Kinetics Corp.

Kinetic isolation pads are said to isolate vibration and eliminate lagging machinery to the floor, without cementing, sawing, waiting, or floor drilling.

Kinetic isolation pads are furnished in 18 × 18 × $\frac{1}{2}$ in. sheets which are prescored at 2 in. intervals for cutting-to-size on the job-site with a pen-knife.

Kinetic vibration control products claim to utilize the extreme elasticity of the glass fibers to result in outstanding isolation efficiency plus high internal damping for machine stability.

By elimination of lag screws and special foundations, up to 90 per cent savings in installation or relocation of machinery is obtained, the company states. —K-10

Metering Line Regulators

The Harris Calorific Co., has announced the development of a new line of metering regulators for all common gases, such as argon, helium, carbon dioxide, and nitrogen.

These regulators, designated the L-40-AR series, will provide sensitive control, highly important in certain industry applications, and will pass 0 to 100 cu ft per hr.

All have $\frac{1}{4}$-in. pipe thread inlets to prevent accidental mounting in high pressure cylinders. —K-11

Pipe Hanger

A hanger for banks of electrical conduit and pipe, designed to cut costs sharply and offer improved construction features, has been announced by the Stamperhanger Co.

Installation cost of the Stamperhanger is claimed about one-quarter that of ordinary hangers, according to the company. Other features include one piece clamps, immediate, and automatic alignment that is said to be permanent even though workmen step on the pipe, interchangeability of pipes within the bank without moving adjacent pipes, a wide variety of clamp sizes. The same clamp fits both iron and other pipes.

Conduit or pipe is held against a channel iron by spring alloy aluminum clamps which slide over the pipe and are held by slots in the channel. A cam on the clamp holds it in place. —K-12

ANOTHER NEW ACHIEVEMENT IN MODERN FLOW CONTROL BY CRANE

1 Single retaining nut holds cartridge assembly in body, for fast, foolproof dismantling and assembly

2 Teflon* thrust washer reduces stem friction; absorbs line pressure load on ball

3 Teflon* seats pre-loaded for tight shut-off with minimum torque

4 Bright plastic grip insulates handle and flags valve position

5 Positive, Standard Size O-ring seals on stem, cartridge

6 Self-aligning, precision-machined ball, polished and chrome-plated to minimize friction and wear on seats.

7 Tapered cartridge contains all working parts; slips out bottom in one piece for cleaning or maintenance

* Teflon is a registered trademark of E.I. DuPont de Nemours & Co., Inc.

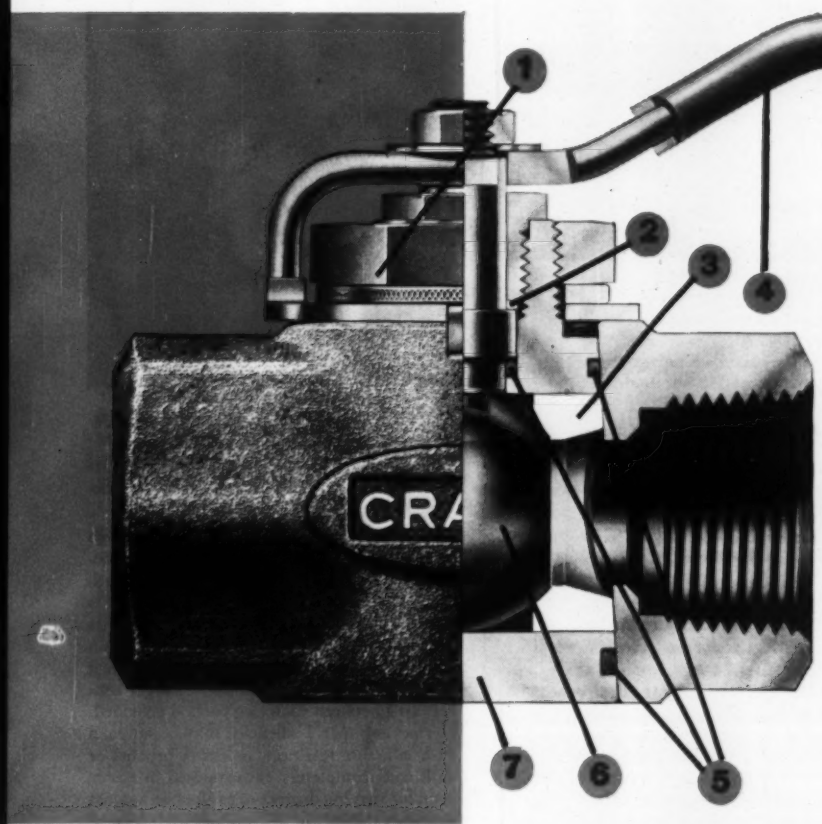
Fight HEART DISEASE # 1 HEALTH ENEMY

Give HEART FUND

CRANE BALL VALVES

with the exclusive tapered cartridge that drops out for fast, in-line servicing

designed to handle all air and water services to 400 F



There's a beautiful simplicity in these newest ball valves—Crane-designed for sure, safe, versatile service. The heart of the valve is a tapered cartridge—remove one retaining nut and the cartridge slips out the bottom for cleaning or maintenance, and then slips back, exactly in place, while the valve body remains in the line. The Teflon* seats are precisely pre-loaded for bottle-tight closing with a quick, easy quarter-turn of the handle—even with air or gas, vacuum to 800 psi, temperatures from —40 to 400 F. The handle is insulated, for hot service, and its bright Crane orange quickly flags the valve position—in-line for open, stand-out for closed.

Crane Ball Valves give you smooth flow; shut off tightly in either direction. All steel parts are plated for corrosion resistance.

Available now for prompt delivery at competitive prices—sizes from ¼" to 2", screwed ends, in bronze, steel and Type 316 stainless.

Call your Crane Distributor or send today for a complete, illustrated folder on the outstanding new Crane Ball Valves, engineered for unmatched service.

CRANE

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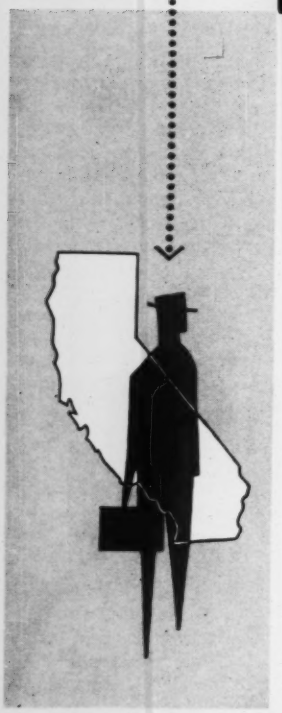
Valves/Electronic Controls/Piping/Plumbing/Heating/Air Conditioning

Who is this man?

First, you should know a few things about him: He's responsible, as a man who leads others through new frontiers must be; he's a specialist . . . but a specialist with time for creative reverie; he welcomes new challenges and grows in learning and stature with whatever he faces; he's mature, dedicated, and inquisitive—traits of a true man of science. Who is he? He's the indispensable human element in the operations of one of the Navy's laboratories in California. Could he be you?



U. S. NAVAL ORDNANCE TEST STATION at China Lake and Pasadena: Research, development, testing, and evaluation of missiles, advanced propulsion systems, and torpedoes and other undersea weapons.

U. S. NAVAL ORDNANCE LABORATORY at Corona: Development of guidance and telemetry systems and missile components. Research in IR spectroscopy, magnetism and semiconductors, etc.

U. S. NAVAL RADIOLOGICAL DEFENSE LABORATORY at San Francisco: One of the nation's major research centers on nuclear effects and countermeasures.

U. S. NAVY ELECTRONICS LABORATORY at San Diego: One of the Navy's largest organizations engaged in the research and development of radar, sonar, radio, and acoustics.

PACIFIC MISSILE RANGE and U. S. NAVAL MISSILE CENTER at Point Mugu: National launching and instrumentation complex, guided missile test and evaluation; astronautics; satellite and space vehicle research and development.

U. S. NAVAL CIVIL ENGINEERING LABORATORY at Port Hueneme: Research, development, and evaluation of processes, materials, equipment, and structures necessary to the design, construction, and maintenance of the Navy's shore bases.

Openings for Aeronautical Engineers, Chemists, Civil Engineers, Electronic Engineers, Electronic Engineers (Digital Circuitry & Electro-Acoustic), Mathematicians (Test Data Processing & Analysis), Mechanical Engineers, Operations Research Analysts, Physicists.

The man we want must have an advanced degree, or a Bachelor's degree with at least three years' solid experience. He should contact . . .

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Laminated Solenoid

Dormeyer Industries has introduced its new Super-T improved line of solenoids designed to replace the former CT Line.

Super-T is a laminated solenoid, with superior electrical and mechanical characteristics, designed to provide lasting, dependable service under adverse conditions. It is claimed more rugged in construction than its predecessor and with a stronger seating pull without excessive a-c hum. The redesigned plunger has a sturdier pull bar. Larger contact area between co-acting parts is provided. Dormeyer Super-T solenoids may be supplied with moisture resistant, moisture proofed or with coils completely encapsulated in epoxy resin for varying degrees of protection against humidity, water or oil spillage or physical damage. Three sizes of Super-T solenoids are available, Models 1000, 2000, and 3000, all especially well adapted to use in business and commercial machines, automation equipment, vending machines, and small machine tools. **—K–13**

Hopper Elevator

A new hopper elevator, designed to facilitate the loading of parts into the bowls of Syntron vibrating parts feeders, has been developed by Syntron Co. These can also be used for loading purposes in conjunction with any automatic or semiautomatic parts-processing system.

They provide an easier, faster method of supplying parts—eliminating heavy manual lifting and subsequent personnel accidents.

A Syntron electromagnetic vibrator keeps the parts moving freely out of the hopper and over the chute. There are no belts, clutches, or other moving, wearing parts requiring high-cost maintenance and replacement. **—K–14**

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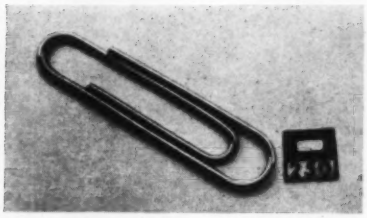

Temperature Indicating Label

Pyrodyne, Inc., has announced its new miniature temperature indicating label, the Model 200 Temp-Plate. Measuring 1/4 in. sq, overall size, the Model 200 Temp-Plate is useful for instrumenting transistors and other miniature electronic components, inaccessible machinery areas, and general industrial or aviation equipment.

The hermetically sealed Temp-Plate 200, a tiny plastic adhesive tab that sticks on almost any surface, turns black when its temperature reaches any desired value between 100 and 500 F. Its accuracy is ± 1 per cent. It provides a record of alarm-limit temperature, shows at a glance whether a part is operable or unsafe. **—K-15**

Permanent Magnet Material

A new lightweight permanent magnet material which has excellent magnetic qualities, comparable to sintered isotropic barium ferrite, yet which may be readily cut by ordinary tools has been developed by the Leyman Corp. Called Plastiform 1, the new material is a rubber bonded barium ferrite, magnetically oriented, with exceptionally high coercive force and an energy product of approximately one million gauss oersteds.

In contrast to sintered magnetic materials, Plastiform is neither hard nor brittle, but may be easily machined or cut. Impact strength of the material is high, and it will not chip in use, the company says. Currently, Plastiform's applications are such as magnetic cabinet latches, holding devices, toys and novelties, d-c motors and gasket inserts. The new material can be supplied in many forms such as rings, sheets and strips. **—K-16**

Rubber Seat Ball Valve

What is said to be a new concept in ball valve design has been announced by the Henry Pratt Co. Utilizing a rubber seat which is fully adjustable, this new ball valve is said to be completely bubble-tight at all pressures up to rated 250 psi. The manufacturer also states this is easiest to operate valve of its type.

They are available in sizes 10 through 48 in. and up, with manual, cylinder, or electric motor operators. Write for Bulletin BA-1. MB. **—K-17**

Push Button

Cutler-Hammer has introduced an oil-tight, illuminated push button that combines the functions of a push button and an indicating light in a single unit.

The C-H illuminated push-button incorporates a color-coded, molded-type transformer that is designed to be immune to voltage-surge lamp damage.

An outstanding feature of the device is the fact that it can operate with multiple contact blocks with any combination of N.O. or N.C. contacts.

Other features include base and one-hole mounting, functionally styled plastic lenses in red, blue, amber, green, clear, or white and a positive mechanical "feel."

Cutler-Hammer's oil-tight, illuminated push-button is available for 110, 220, 380, 440, and 550-volt applications. Ask for Pub. LO-104. **—K-18**

Small Computer

Said to be the newest in small computers, the Recomp III is produced by the Industrial Products organization of Autonetics, Div. of North American Aviation, Inc.

Recomp III will be particularly useful to the scientists and engineers in the small to medium-size engineering firm, the company says, adding the versatile machine can also be used as a "real time" computer in the process control field.

The new machine has a 4096-word magnetic disk memory with each word having 40 bits. The computer can handle more than 8000 instructions. It uses a simplified command list of 32 standard commands plus five compacted floating point commands. Standard input and output is 10 characters per second by Flexowriter or paper tape punch.

Use of the optional Facitape input/output equipment increases inputs to the computer to a rate of 600 characters per second and output to 150 characters per second.

In addition, Recomp III provides four input and output plugs where additional optional equipment such as card readers, magnetic tape, line printers, and analog-to-digital converts can be used thus further extending the computer's capabilities.

Main memory access time is 9.3 ms and using the two high speed loops this time can be reduced to 1.75 ms. Operation time for fixed point computations is 0.54 ms for add-subtract functions; 10.8 ms for multiplication and 11.1 ms for division.

Using the optional floating point, add-subtract time is 1.1 ms; multiplication, 12.4 ms and division, 12.7 ms.

Recomp III operates off of any standard 115 volt, 50–60 cps, ac power source. Total computer size, including desk, is just 30×-30×60 in. For on-line use, the desk portion of the computer can be detached leaving only the functional computer module. Weight is 250 lb. **—K-19**

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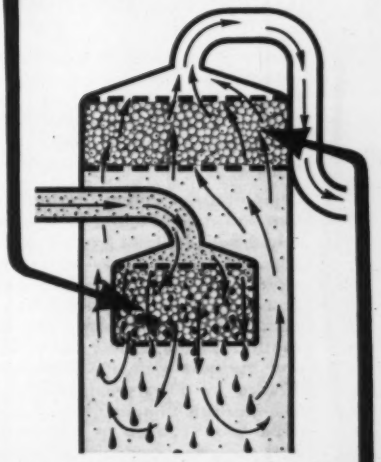

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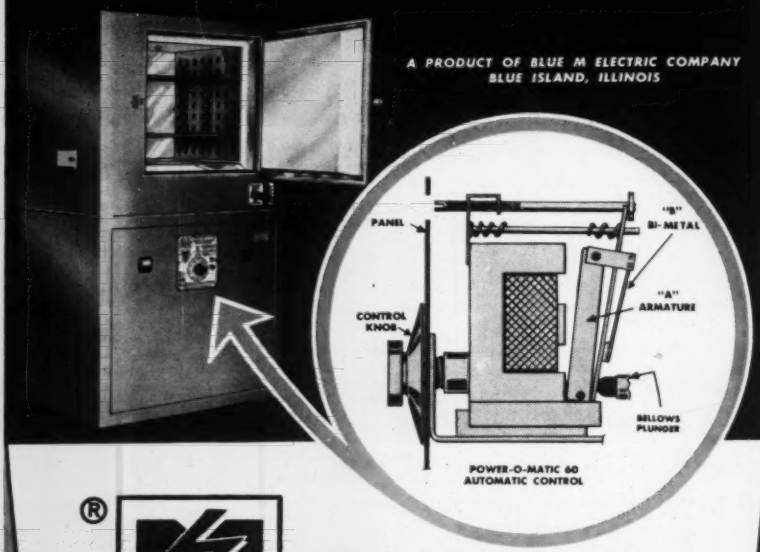

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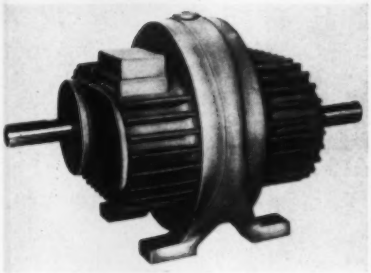

Reversing Transmission

A five-hp transmission which provides virtually instantaneous reversing—claimed in 0.2 sec under worst conditions—has been introduced by Airborne Accessories Corp.

The new transmission, designated Electromission, was developed primarily to provide high-speed positioning, reversing, and sequencing of loads for industrial servo systems and automated systems using card or tape control.

Electromission consists of an input and an output shaft, connected through either a gear drive or a chain drive, depending upon the status of two opposing electromagnetic clutches. Engaging one clutch provides chain drive, for same-direction rotation of the output shaft compared to the input shaft. Engaging the other clutch produces gear drive, for opposite-direction rotation of the output shaft.

When both clutches are disengaged, the transmission runs free in a neutral position. If the application requires holding the load in a fixed position when no signal is present a brake can be incorporated in the transmission, with provision for energizing it automatically in the absence of positioning signals.

Rated five hp at 1750 rpm, the unit is capable of transmitting torques in excess of 250 lb-in. under transient conditions, while its capability under steady-state conditions at any desired speed is 180 lb-in. The difference between maximum capacity and steady-state requirements is the reserve available for acceleration.

The unit is approximately $10^1/_2$ in. high, $9^1/_2$ in. long exclusive of shafts, and $10^1/_2$ in. high. It weighs 55 lb as a standard unit, 62 lb with a brake added. Control power of approximately 10 watts at 90 volts d-c can be supplied from a convenient packaged rectifier operating from a conventional 110-volt single-phase a-c supply. **—K-20**

Read the Classified Ads appearing in the "Opportunities" Section each month

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Microwire Welding

Hobart Brothers Co. has announced a new process which is said to eliminate the need for a manual stringer bead or for a backing ring, has been developed for the fully automatic roll welding of pipe.

The automatic submerged-arc welding process is successfully employed in shops for subassemblies and for double-ending line pipe, but it is necessary either to use a backing ring, or weld the first pass with manual arc or tungsten-inert-gas process.

The new Hobart Microwire welding system which employs carbon dioxide as the shielding gas is said to have had successfully butt welded pipe laying the stringer bead automatically without use of a backing ring.

The microwire automatic welding equipment includes a wire feeder coupled to a specially designed constant voltage motor generator welder. Filler wire is fed to a fixed welding torch for flat position or roll welding, or to a lightweight hand torch for semiautomatic applications.

The water-cooled torch contains the current pick-up tube and the electrode wire. It also directs the carbon dioxide shield into the welding zone, prohibiting atmospheric contamination of the weld.

The microwire process differs from conventional CO_2 Mig methods in that an extremely small-diameter wire—usually from 0.200 to 0.045 in. electrode is used. An extremely low arc voltage, in the range of 16 to 20-volt and a low current, from 30 to 150 amp d-c reverse polarity, are employed.

—K–21

Ion Pump

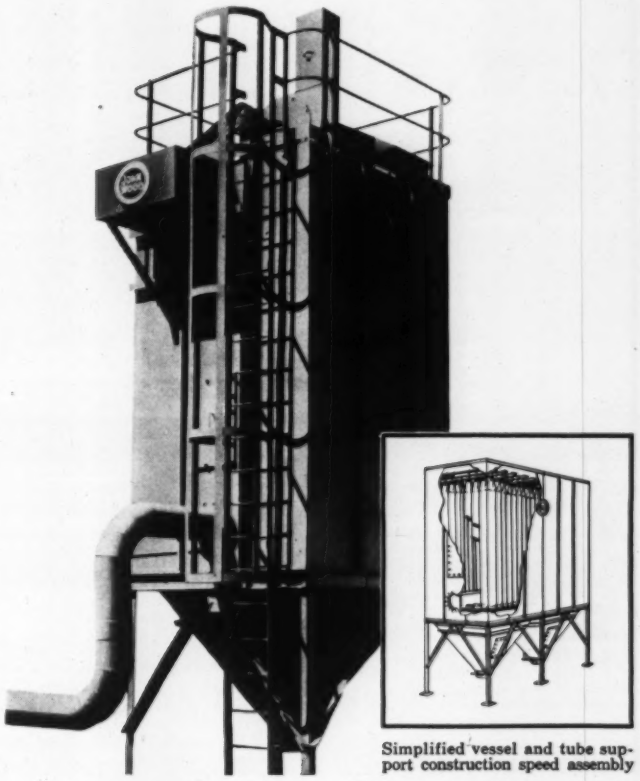
A new, large vacuum ion pump for use in the ultra-high vacuum field has been announced by Consolidated Vacuum Corp., a subsidiary of Consolidated Electrodynamics/ Bell & Howell.

The new PDV-300 DriVac pump is an electronic getterion pump utilizing a three-electrode construction which insures higher pumping speeds and eliminates pressure surges when operating against inert gases.

The features of the PDV-300 DriVac pump make it especially useful for ultra-high vacuum applications such as semiconductor processing, vacuum tube processing, electron microscopes, particles accelerators, and fieldemission, electron beam and molecular beam studies. It has a nominal pumping speed of 300 liter per sec with an ultimate pressure of 2×10^{-13} mm Hg.

A stainless steel pump casing, capable of withstanding bakeout temperatures up to 450 C, has a standard 6-in. 150-lb ASA flange and a flat gasket surface suitable for a metal wire gasket seal. The only part of the new DriVac pump said to be subject to wear is the sputter-cathode which has an expected life of 200,000 hr if the pump were operated at a set pressure of 1×10^{-7} mm Hg. Ask for Bulletin 6-2. —K–22

New Ideas On Dust And Fume Control



Simplified vessel and tube support construction speed assembly

New Products:

John Wood High Efficiency Fabric Filter

John Wood Fabric Filters are engineered for 99.9% efficiency in addition to trouble-free operation. They are the result of a program to design equipment for fully effective removal of all dry dusts at elevated operating temperatures.

An extremely varied group of filter sizes, shapes and types is available in capacities from 100 CFM to 48,000 CFM. Larger volumes are handled through a combination of units. John Wood automatic reverse flow mechanisms or shaker assemblies assure proper and gentle cleaning of fabric. Tubular or envelope bags are made of cotton, orlon, dacron, nylon or glass to meet any requirement.

New Engineering: John Wood Fabric Filters are but part of the complete line. Other equipment includes Interphase Reaction Scrubbers, Multi Cyclones, Involute Cyclones, Venturi Scrubbers and combination units. New designs are now under development.

New Service: John Wood Air Pollution Control is fully programmed from analysis of existing conditions to equipment installation. Frequently economies result that make the installation self-liquidating through lower maintenance and replacement costs.

Write for engineering assistance or specific product information. An air pollution preliminary analysis kit is available without obligation.

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VISCOSITY OF LUBRICANTS UNDER PRESSURE

This Report reviews twelve experimental investigations made in England, Germany, Japan, Russia, and the United States on 148 lubricants comprising 25 fatty oils, 94 petroleum oils, 17 compounded oils, and 12 other lubricants. Data collected are co-ordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Pertinent topics such as experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Other sections give the required computation of temperature and pressure coefficients, a bibliography of 189 items, and symbols.

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Cam-Follower Bearings

Two series of heavy-stud cam-follower roller bearings have been added to the Camrol line by the bearing division of McGill Mfg. Co.

A heavy-duty series has increased-diameter studs that provide greater shear strength to accommodate excessive stud deflection in critically loaded track, guide, support, and cam-follower applications. Included in the two series are the regular CFH models and SCFH models with integral seals. Both are interchangeable with standard cam followers except for the larger stud diameters. Roller diameter for both models start at 0.5 in.—stud diameters from 0.25-in. Capacity range is from 470 to 20.750 lb at 100 rpm. Special sizes available upon request.

All component parts of these new bearings are of heavy-duty construction. They feature full-race-width rollers and a hardened end plate to resist wear under misalignment. The SCFH integral-seal-series bearings have specially treated synthetic seals contained in the race undercut to provide labyrinth sealing to efficiently retain lubrication and lock out contamination. Both models can be relubricated. —K-23

Magnet Material

Alnico VII-S, a new permanent-magnet material with outstanding magnetic properties in the nonoriented condition, is being produced for use in magnetic-core-type meters and instruments by the Indiana Steel Products Div., Indiana General Corp. The new material has a nonoriented energy product of 2.5 million and eliminates the problem of aligning orientation direction in the meter. Further, unoriented core magnets provide a more uniform gap density, providing a more linear and accurate scale in the meter than was formerly possible with oriented materials.

Alnico VII-S is also available in the oriented condition which yields an energy product of 3.7 million.

This new magnetic material exhibits an extremely high coercive, H_c, force, which is considerably higher than that of most other materials in the Alnico family. For this reason it resists demagnetization even when subjected to high environmental heat often associated with core-type meters and instruments. Alnico VII-S is also useful where magnetic length is limited. —K-24

Venturi Meters

Accurate and reliable series of small flow meters, developed by Flow-Dyne Engineering, start at air flows of 0.05 lb per min. with throat sizes from 0.1 to 4 in. Either precision calibrated or standard (within 3 per cent) available. —K-25

FOR CONSULTING ENGINEERS TURN TO PAGE 167

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Speed Reducer

The MW109 Ratiomotor, offering a broad selection of low output speeds, has been added to the standard stock models available from Boston Gear Works distributors.

A worm-geared, horizontal, parallel-drive model, the MW109 is powered by specially designed $^1/_{20}$-hp or 0.035-hp motors, and provides output speeds from 1.9 to 70 rpm. —K–26

Interchangeable Cylinder

A new interchangeable cylinder, for 250 psi air, and up to 2500 psi oil service, has been announced by the Alkon Products Corp.

The Series B cylinder line is designed for increased cycle life, higher efficiency, and reduced maintenance. Its features include low-friction nylon piston bearings, case-hardened piston rods, chrome-plated barrels, and piloted, quick-change rod packing cartridges.

The nylon piston bearing alleviates scoring and lengthens barrel wall life. The case-hardened, chrome-plated alloy steel piston rod, with 125,000 psi yield strength, is ground and polished to a 2-micro-in. finish to extend seal life and resist impact damage and scoring. Self-adjusting block-vee rod packings automatically compensate for wear with negligible breakout friction. For maintenance, a quick-change rod bushing and packing cartridge is piloted into the cylinder head, threaded into a bearing retainer. Series B cylinders are stocked in standard bore diameters from $1^1/_2$ in. through 6 in., in a variety of mountings and stroke lengths. Modifications are also available as required. —K–27

Packaged Fire-Tube Boilers

A complete line of packaged fire-tube boilers commonly used where reliable steam and a guaranteed efficiency are required, is manufactured by Cleaver-Brooks Co. Compact and high-efficiency packaged fire-tube boilers are built in sizes from 15 through 600 hp (520 to 20,700 lb per hr of steam).

Exclusive engineering features of Cleaver-Brooks boilers are the four design standards to which the boilers are built. These are (a) Four-pass design, (b) forced draft, (c) 5 sq ft of heating surface per boiler hp, and (d) updraft construction. Each plays a part in the efficient operation of the boiler. It should be noted that the forced-draft system provides all air for combustion in the proper quantity and eliminates the need for a high chimney and induced-draft fans.

Features such as air-atomizing burner, single-tip retractable nozzle, air purge of burner nozzle, unique air compressor, forced-draft system, caseless fan, the combination steam and electric heater for heavy-oil models, hinged doors, are all a result of Cleaver-Brooks research and development program. —K–28

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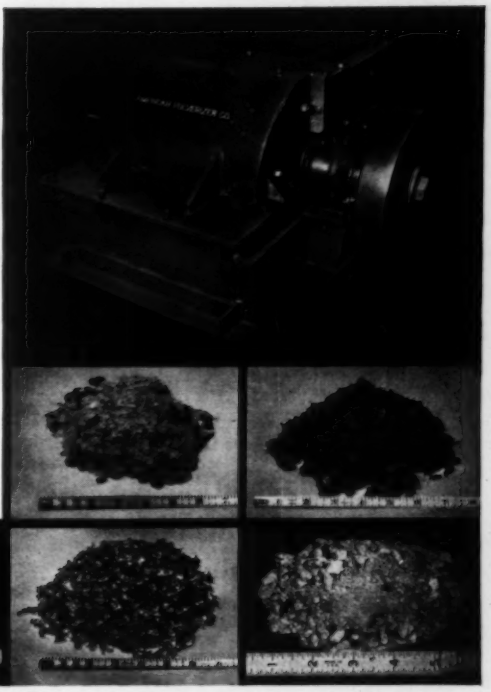

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This Niagara design also saves you much labor and money in installation and upkeep. Its cleanable coils are easily accessible, as are all interior parts. Its panels are removable for cleaning and painting. It is easy and inexpensive to keep in "new machine" condition.

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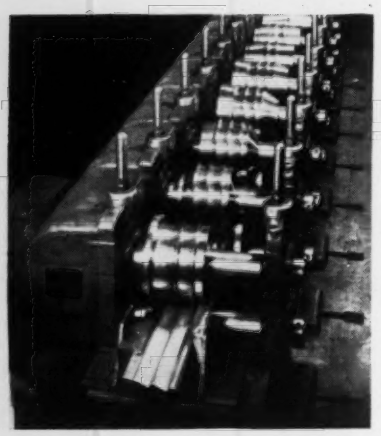

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Hydraulic Relief Valves

Parker-Hannifin Corp. has announced new pilot-operated relief valves for machinery hydraulic systems.

The new relief valves have been engineered for a minimum 5-to-1 safety factor over rated operating pressure. The line-mounted-type valves are for 3000 psi hydraulic systems while the gasket mounted units are rated at 5000 psi. Both series are provided in rated capacities of 20 and 50 gpm. Subplates are offered for use with the gasket-mounted type.

The valve bodies were designed for SAE hydraulic straight threads (as well as pipe threads). Valves can be held with standard wrenches or in a vise when installing fittings. The valves can be mounted in any position.

The valve opening pressure is controlled by the pilot valve which is easily adjusted and locked. The adjustment control may be installed in any of four positions relative to the valve for easy accessibility. Captive pilot design permits safe adjustment during operation. **—K-29**

Impactools

Two new Ingersoll-Rand Co. torque-control Impactools feature detachable torsion bars to increase the speed and accuracy of driving nuts, bolts, and cap screws to a variety of precise torques. To change the torque delivered by either tool, the operator simply snaps on a different preset torsion bar; it's as easy as changing sockets. With the new Size 5020TD and Size 5040TD torque-control Impactools, it is not necessary to reset the tool for each torque, nor is it necessary to use a whole array of Impactools to deliver a needed variety of torques.

Each of the two new tools is available with heavy and light-torsion bars. The light-torsion bar for the 5040TD Impactool may be set for torques from 20 to 50 ft-lb while the heavy-torsion bar covers from 45 to 90 ft-lb, giving a range of 20 to 90 ft-lb. Similarly, the light and heavy-torsion bars for the 5020TD Impactool may be set for 6 to 17 ft-lb and 10 to 30 ft-lb, covering a range of 6 to 30 ft-lb. Through use of several torsion bars, each preset for a desired torque, one Impactool will handle a wide variety of desired torques within its overall torque range. **—K-30**

Air-Powered Nibbler

Manufactured by Fenway Machine Co., Model EAN portable hand nibbler is pneumatic operated, designed for extra heavy duty cutting of $^1/_4$ in. steel plate, 8-gage stainless and $^5/_{16}$-in. aluminum. Its cutting speed is recorded at 40-45 in. per min. Model EAN also cuts any size radius from 8 in. Weighs only $18^1/_2$ lb.

Model EAN features precision cut, hardened steel gears; all rotating parts operate on anti-friction bearings for durability and ease of operation. **—K-31**

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Troublesome maintenance and lubricating problems are eliminated when you specify Thomas "All-Metal" Flexible Couplings to protect your equipment and extend the life of your machines.

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Measuring Press Loads

Two electronic precision instruments are available from Niagara Machine & Tool Works which safeguard against damage to presses and dies during production runs.

The Niagara load monitor, Model 112, is designed for continuous measurement of all press loads on a given press. It responds instantly and accurately regardless of press speed. Consisting of a control unit located conveniently near the press, plus two or four pickups mounted permanently on press frame or tie rods, the load monitor registers loads from 0 to 140 per cent of press capacity. To prevent over-load repeats, it is equipped with a special tripping circuit which disengages the clutch when the preselected percentage of press capacity is reached. It can also be arranged to actuate a warning signal. All adjustment controls are key-locked to prevent tampering by unauthorized personnel. Because of their small size, 4 × 2 × 1 in., the pickups can be mounted well out of the way of die space and feeds.

The Niagara Tonmeter, Model 119, is a portable instrument designed to show the maximum load on a press during operating cycle as well as die setting. To operate, the Tonmeter is plugged into pickups mounted on the frames of the press or presses to be checked. Like the load monitor, it responds instantly and accurately regardless of press speed.

Because the battery-powered Tonmeter requires no electrical outlet and is easy to carry, one individual can check the "percentage of full load" on several presses in a matter of minutes. Setting the simple press-factor dial calibrates the meter for each press. Accurate readings and compact size are the result of latest developments in miniaturized electronic components. To maintain accuracy, the Tonmeter is designed to prove its own calibration and test its own battery for assurance that operating power is within prescribed limits. **—K–32**

Optical Comparator

The Micro Vu 300, a low cost optical comparator to permit decentralization of quality control and inspection to numerous points of manufacture has been announced by Micro Vu.

Designed as a portable unit, the Micro Vu 300 provides 20 power magnification for precise visual inspection of details of components ranging in size from microminiature parts to 3 in. A.N. fittings, contours of cutting or forming tools and small assemblies.

The Micro Vu 300 needs less than 3 sq ft of bench area and weighs approximately 20 lb. Hand fitted to insure accuracy, the unit features a 20X Achromatic color corrected lens, an eight-in. screen to permit viewing under normal room lighting (a full line of accessary screens are available), 2½ x 9-in. measuring stage with 3 x 3-in. vertical and horizontal travel, and standard dial indicators. **—K–33**

SPACE, TIME *and* DR. KARPLUS

$$\frac{\partial}{\partial t} \rightarrow \Delta$$

Enthusiasm & Equipment for analog computing and model building have been purveyed by Philbrick Researches since 1946. The processes synthesized and studied by such techniques as these are generally the sort described by *total differential equations.*

When Field Problems place *partial differential equations* on the stage, the analog impresario recasts them as the former kind by lumping in space. As to time, though he may scale it, he is loath to lump it. Transient fields are transformed by him into models which are Discrete in Space, but Continuous in Time.

Numerical solution of field problems, whether carried out by a Giant Digital Brain or by a tiny human one, proceeds by transforming to *difference equations.* Everything is made discrete: even the dependent variables of the field.

An intermediate technique is recommended by Dr. Walter J. Karplus*, which is called DSDT: for Discrete Space and Discrete Time. He retains the continuity and convenience of analog voltage for field variables, but formulates the solution in a novel manner with difference equations. The Karplus method† is compatible with analog equipment of the kind we make and sell, and we should naturally be happy to send data on the subject to responsible enquirers.

*Associate Professor, University of California, Los Angeles
†Philbrick Researches is licensed exclusively by Dr. Karplus to apply his DSDT invention.

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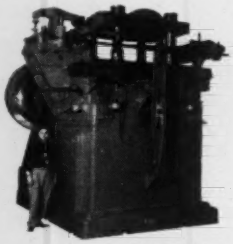


"WE RECOMMEND LUBRIPLATE FOR HENRY & WRIGHTS"

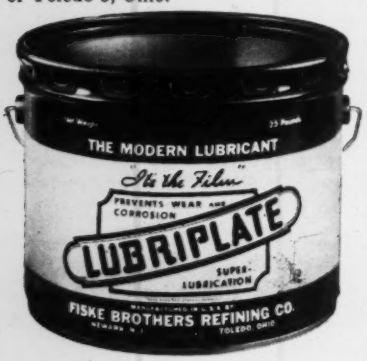
—says
The Hydraulic Press Mfg. Co.
A Division of Koehring Co.
of Mount Gilead, Ohio

"We have had excellent results with LUBRIPLATE in our new double crank design Henry & Wright Dieing Machines which we recently acquired from Emhart Mfg. Co., Hartford, Conn. This follows the same fine results Emhart had with LUBRIPLATE in single crank Henry & Wrights for many years. In the Operating Manual that goes with every new Henry & Wright machine, you will find that we recommend LUBRIPLATE."

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

LUBRIPLATE is available in grease and fluid densities for every purpose . . . LUBRIPLATE H. D. S. MOTOR OIL meets today's exacting requirements for gasoline and diesel engines.

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.



KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Industrial Balancing Machines

Form 24–1 describes Stewart-Warner Corp. Industrial Balancer, which electronically detects the location and amount of unbalance in a rotor. Both kinetic and dynamic unbalance are obtainable. The balancer consists of a drive system, a cradle, vibratory system, electromagnetic dashpot-pickups, and electronic interpreter. It is intended for production and job-type balancing. Three models are available: Model 702, Model 704, and Model 708. **—K–34**

Flow Regulator

An externally adjustable cartridge-type low-capacity flow regulator, designed to maintain constant regulated flow regardless of variations in pressure, has been announced by Fluid Regulators Corp.

Whenever the inlet flow exceeds the valve setting, this new valve opens to bypass flow to the reservoir and maintains constant flow to the circuit.

Used in hydraulic circuits requiring low flow, the valve has an adjustable regulated flow of 0 to 0.5 gpm and an adjustable total flow-control rate of 5 per cent within a 600 to 2000-psi operating-pressure range. In addition it has a low pressure drop of 50 psi at 0.13 gpm.

Weighing only 9 oz, the valve is constructed of stainless steel and anodized aluminum and will handle all fluids compatible with these materials. **—K–35**

Drum Cooler

The Roto-Fin cooler, a basically new conduction-type drum cooler which can handle fine materials at high temperatures and cool them rapidly and efficiently, has been announced by Link-Belt Co.

The Roto-Fin is a rotating drum with a series of flat, dual-purpose hollow fins or "cells" lapped to form an Archimedes spiral around the inside of the shell. As the cells are welded together, their surfaces form one continuous spiral. Yet individually, each cell is a separate heat exchanger, with an opening on the outer periphery of the drum.

As the drum revolves partly submerged in water, the material to be cooled is conveyed down its spiral length from one turn in the spiral to the next. The openings of the individual cells continuously scoop up cold water and empty with each revolution of the drum to realize over all heat-transfer coefficients as high as 20 Btu per hr per sq ft deg F on high-temperature applications.

Because of the large amount of conduction-cooling surface incorporated in the design, a relatively short drum is required.

The Roto-Fin cooler is safe for high-temperature applications, since steam is free to escape through large hood stacks, rather than through restricted pipes. The cooler has a minimum of moving parts. No fans, dust collectors, or controls are required. **—K–36**

Air Compressor

Atlas Copco has introduced a 400-hp stationary air compressor delivering 2280 cu ft of air per minute.

The manufacturer said this machine is designed for heavy-duty, three-shift operation in engineering factories, chemical plants and other industrial locations as well as on construction jobs and in mines. Installation time is claimed minimized since the compressor is delivered as a complete unit and only requires bolting to a simple steel frame preset in the concrete foundation. Designated the ER 8, the new Atlas Copco compressor is a two-stage, double acting, water cooled unit with cylinders placed in "L" arrangement.

The ER8 is said to have an exceptionally high capacity to weight ratio, obtained primarily by the short-stroke design. Equipped with a water-cooled intercooler and fitted with an automatic condensate drain valve, this machine is rated for working pressures up to 125 psi. Output of the ER8 is 2280 cfm at 100 psi when running at 514 rpm. Machine weight is 11,700 lb. Roughing-in dimensions for the ER8 are $94\frac{1}{2}$ in. wide, $63\frac{1}{2}$ in. deep and $93\frac{1}{2}$ in. tall. **—K–37**

Motor-Generator

"No-break power" is provided by a new motor-generator, with a unique flywheel arrangement specially developed by Kato Engineering Co. In case of failure of normal electric power, the momentum of the large flywheel is designed to keep fluctuation to a minimum until the standby power plant is cut into the line.

The motor-generator set features a brushless-type generator with direct-connected separate exciter, is rated at 5 kw, 6.25 kva, 0.8 factor, 120 volts a-c, one phase, 50 cps. A Kato mag-amp regulator provides $1\frac{1}{2}$ per cent of rated voltage under one-fourth-load to full-load conditions. Rectifier assembly is mounted on end of shaft for easy replacement of rectifiers.

Motor is 10 hp, 208/416 volts a-c, 1500 rpm, 50 cps, 3-phase, wound-rotor induction type. **—K–38**

Proportioning Pumps

A new series of small-volume high-pressure chemical proportioning pumps is now available from the American Instrument Co. for applications where small volumes of fluid must be handled at pressures to 30,000 psi. A choice of pressures from 7500 psi to 30,000 psi is offered in either simplex or duplex model pumps; capacities range from 0.84 to 6.44 gal per hr.

One feature of the pumps is an adjustable stroke length which, regardless of its span of travel (short or long stroke), is said to completely evacuate the cylinder and permit efficient pumping of highly compressible liquids. **—K–39**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Fibrous Glass Sound Deadener

Molded fibrous glass in specially designed shapes is now being used to suppress high-frequency noises generated by the compressors of unit air conditioners. This type of acoustical insulation is made by Fibrous Glass Products, a subsidiary of Pall Corp. The noise suppressor unit is fabricated in two halves, designed for rapid and simple assembly. It is sprayed with a vinyl surface coating to aid in handling.

These molded units have an insulation density of about 6 lb per cu ft, providing a maximum of acoustical insulation with a minimum of weight or space. They replace pasted insulation for many uses and, due to ease of installation, are said to make possible a reduction in over-all costs.

—K–40

LATEST CATALOGS

Applications of Felt

A+ Felt Applications Guide contains solutions to material engineering and design problems and illustrates the scope of advanced engineering and research available from American Felt Co., for felt of both wool and all synthetic fiber constructions. Technical Bulletin 8-60 is a comprehensive survey of physical, mechanical, and chemical properties and fabricating methods of wool felts.

—K–41

Electric Motors

An eight-page Bulletin 2651, issued by Louis Allis Co., outlines an extensive line of electric motors to meet a broad field of application requirements.

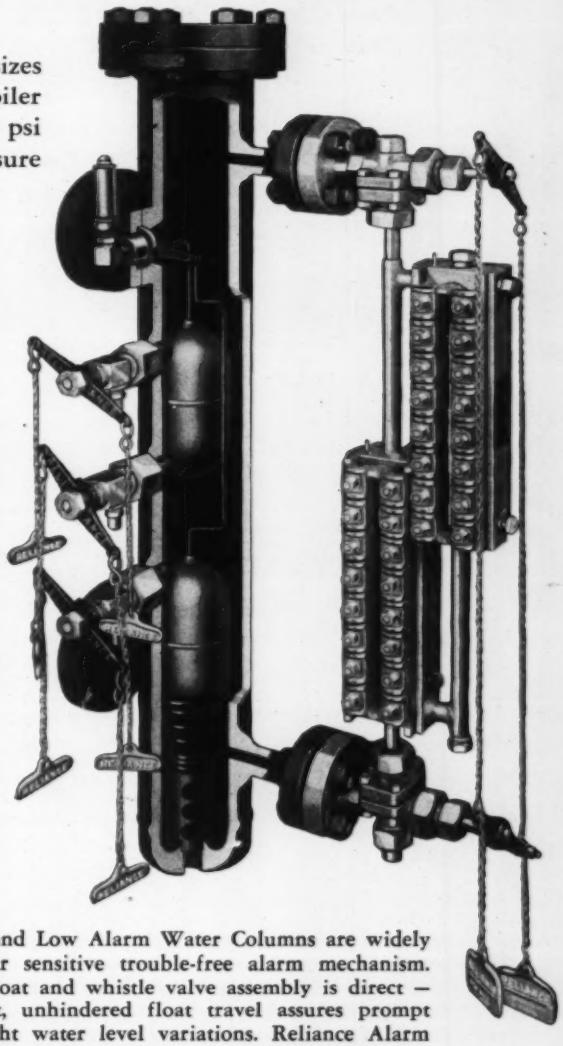
The bulletin features 23 types of motors with photographs and brief descriptions on application uses and available ratings enclosures and modifications.

The line includes standard squirrel-cage motors in ratings from 1/4 to 2500 hp and available in open, enclosed, explosion- and weather-protected enclosures along with many modifications such as C or D flanges, P base, and vertical mounting. It also includes gearmotors to 150 hp, d-c motors to 400 hp, wound rotor motors to 800 hp, synchronous induction motors to 150 hp, plus alternators, generators and associated control. Other specialized motors include vertical pump motors, immersible motors, brakemotors, rapid-reversing motors, textile motors, rolled shell shaftless and compact pancake motors. In addition, many special mechanical and electrical motor designs can be readily supplied, including liquid-cooled, precision spindle and multi-speed types.

—K–42

Insure safe, continuous boiler operation with **Reliance** Water Columns

Models and sizes for every boiler need to 2500 psi working pressure



Reliance High and Low Alarm Water Columns are widely known for their sensitive trouble-free alarm mechanism. Action of the float and whistle valve assembly is direct — foolproof. Short, unhindered float travel assures prompt response to slight water level variations. Reliance Alarm Columns, available to 900 psi, are completely assembled at factory and thoroughly tested before shipping . . . Above 900 psi, forged steel columns can be equipped to supply electric alarm service and other safety controls . . . Reliance also makes gage cocks, gage valves, gage inserts, illuminators and vision-focusing hoods in various styles to suit all needs. Engineer representatives in all principal cities.

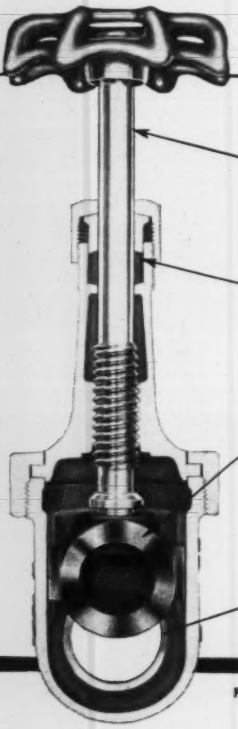
The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

Reliance® BOILER SAFETY DEVICES

Outstanding Valve performance with

KENNEDIZED DISCS

an entirely new development in bronze gate valve construction that extends service life beyond comparison . . .



PROVEN BY USE!

KENALLOY STEM...

Exclusive KENNEDY alloy that prevents dezincification and corrosion and provides smooth, non-galling threads and bearing surfaces. In a rugged use test, this stem withstood a mechanical loading of 18 foot-pounds closing torque and after 25,000 cycles was like new!

PACKING...

New type packing made of molded graphite asbestos with a Buna "N" binder required no replacement during or after 25,000 cycles.

KENNEDIZED DISC...

In punishing use tests, the super mirror finish of the KENNEDIZED disc actually improved with wear! Disc showed no galling or other wear marks after 25,000 cycles at 150 lbs. saturated steam pressure. This remarkable wear resistance is combined with an extremely low coefficient of friction, smooth sliding properties, excellent anti-seizure characteristics and corrosion and galling resistance. Tests and in-use results prove these discs set a new and unmatched high standard in valve performance.

SEAT...

Due to the low coefficient of friction and smooth sliding properties, the action of the KENNEDIZED disc actually improved the finish on the seat. Here, again, no galling was found on the seat after 25,000 cycles.

For the complete KENNEDIZED DISC story, write for Bulletin 574.

Fig. 525KD
125-Pound S.W.P.
Bronze Gate Valve.

KENNEDIZED DISCS NOW AVAILABLE IN THESE KENNEDY VALVES . . .

FIG. 427KD
125-Pound S.W.P. Bronze Gate Valve— Non-Rising Stem, Inside Screw, KENNEDIZED Wedge Disc.
WORKING PRESSURES: Saturated Steam, 125 lbs.; W.O.G., Non-Shock, 200 lbs.

Fig. 525KD
125-Pound S.W.P. Bronze Gate Valve— Union Bonnet, Rising Stem, Inside Screw; KENNEDIZED Wedge Disc.
WORKING PRESSURES: Saturated Steam, 125 lbs., W.O.G., Non-Shock, 200 lbs.

Fig. 78KD
200-Pound S.W.P. 550° F. Bronze Gate Valve— Union Bonnet: ¼"-2"; Bolted Bonnet: 2½"-3", Rising Stem, Inside Screw; KENNEDIZED Wedge Disc.
WORKING PRESSURES: Steam at 550° F., 200 lbs.; W.O.G., Non-Shock, 400 lbs.

Fig. 518KD
300-Pound S.W.P. 550° F. Bronze Gate Valve— Union Bonnet: ¼"-2"; Bolted Bonnet: 2½"-3"; Rising Stem, Inside Screw; KENNEDIZED Wedge Disc.
WORKING PRESSURES: Steam at 550° F., 300 lbs.; W.O.G., Non-Shock, 600 lbs.

KENNEDY VALVE MFG. CO.
ELMIRA, NEW YORK

• OFFICE AND WAREHOUSES IN PRINCIPAL CITIES

DUCTILE IRON VALVES • CAST IRON VALVES • BRONZE VALVES • INDICATOR POSTS • FIRE HYDRANTS

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Ring Ball Bearing

The Fafnir Bearing Co. has produced a 60-page catalog on wide inner ring ball bearings and power transmission units. The catalog contains complete specification charts, diagrams, and photographs. Wide inner ring ball bearings are designed for users who need ball bearings which can be easily mounted on straight shafts and positioned without shoulders, locknuts, or adapters. The catalog also contains a complete line of Fafnir power transmission units, such as pillow blocks, flange cartridges, cylindrical cartridges and take-up units. All types of power transmission units incorporate the company's wide inner ring ball bearing with self-locking collar. **—K–43**

Groov-Pins and Drive Studs

A 12-page, 2-color catalog which describes the various types, dimensions, and fastening applications of solid Groov-Pins and grooved drive studs has been released by Groov-Pin Corp.

A key feature of the new catalog is the arrangement of engineering data on these products. The engineering information is now consolidated. This is said to permit engineers, designers, and other users to design the pins into their assemblies without having to request further details from the manufacturer.

The catalog describes materials used, drilled hole tolerances, shear strength, maximum torque, insertion forces, horsepower transmitted and other important data needed for engineering and design purposes.

The catalog also describes and illustrates the basic principle of grooved pins and shows how they lock effectively in comparison with standard taper pins.

It also shows the various types of drive studs Groov-Pin manufactures, and some of their typical applications as well as dimensional and other specifications. **—K–44**

Silicone-Modified Rubber

A 48-page two-color technical manual on Silicone Modified Rubber issued by Stoner Rubber Co., explains applications of SMR rubber in the rocket and missile industry. It includes the various types of SMR compounds, insulation data, and plastic laminates. Properties are listed. **—K–45**

Emergency Generating Sets

Bulletin 2900, Publication AEB704.2, describes the complete range of Fairbanks-Morse & Co. generator types and sizes, which includes gasoline, LP, and other dry gas fuel units of 400 watts to 150 kw, and diesel units of 3 to 2500 kw. Complete data selection tables outline various cycle, phase, and volt characteristics. Models are available for manual, remote control or fully automatic operation, as well as portable, stationary, and mobile service. **—K–46**

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USE THE POSTAGE-FREE CARDS . . .

If you would enjoy receiving additional engineering information on any of the products

advertised in this issue or

detailed in the Keep Informed Section

. . . . . circle the page numbers of these advertisements or items on one of the cards below . . . . . fill in your name and mail to us. Your requests will be promptly forwarded. All information will be directed to you.

(Note: Students please write direct to manufacturer.)

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2	18	125	136L	146R	188BR
4	19	126	136R	147	189L
4, 7	20	128, 129	137R	149	189R
8	21	131	138	151	160
9	22	132	139	153	169
10, 11	23	133	140	154	170
12, 13	24	134TL	143	155	IFC
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K-7	K-17	K-27	K-37	K-47	K-57	
K-8	K-18	K-28	K-38	K-48	K-58	
K-9	K-19	K-29	K-39	K-49	K-59	
K-10	K-20	K-30	K-40	K-50	K-60	

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(Note: Students please write direct to manufacturer.)

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NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

MECHANICAL ENGINEERING
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KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Rubber Products for Industry

Manhattan Rubber Div., Raybestos-Manhattan, Inc., has issued a revised condensed general catalog M5, succinctly describing the company's complete line of rubber products for industry. Included in the 24-page catalog are sections on Raybestos-Manhattan patented Poly-V Drive, V-belts, transmission belt, conveyer belt, and all types of hose, flexible rubber pipe, and expansion joints, plus a summary of molded and extruded products.

In addition to basic specifications and information for ordering the new catalog details the design and operating advantages of such new and newly constructed products as CX molded V-belts, length stabilized Condor V-belts, Ray-Man heavy duty conveyer belt for 45 deg idlers, hot material belts, new coalmover coal mine belt, Wedlok splice that eliminates vulcanizing and high pressure burst-proof steam hose. **—K-47**

Bucket Elevators

A 22-page booklet on industrial bucket elevators for the handling of bulk materials has been issued by Hewitt-Robins Inc. The booklet, Bulletin No. 174, contains engineering data on various types of bucket elevators and recommends the grades of belting best suited for elevating materials of different weight, abrasiveness, temperature, and other characteristics.

One section deals with belt selection procedures based upon formulas developed over many years' experience in the design of elevators. Another section presents statistical tables on steel elevator buckets. There are also sections on trouble-shooting and belt splicing. **—K-48**

Electrostatic Paint Systems

Availability of an eight-page, illustrated catalog describing centrifugal type electrostatic paint spray systems and equipment has been announced by Ionic Electrostatic Corp. Bulletin 100 explains the limitations of conventional electrostatic spray equipment, then discusses the technique of atomization by air and centrifugal force, and the subsequent use of electrostatics to charge and guide preatomized particles of coating material.

This technique is said to make it possible to extend the use of electrostatic spray methods to include conductive, water base, and a wide range of standard paints without special formulation.

After a preliminary discussion of electrostatic spray methods, the catalog presents the complete line of stationary and portable equipment offered by the company. Power supplies and accessory equipment are also included. **—K-49**

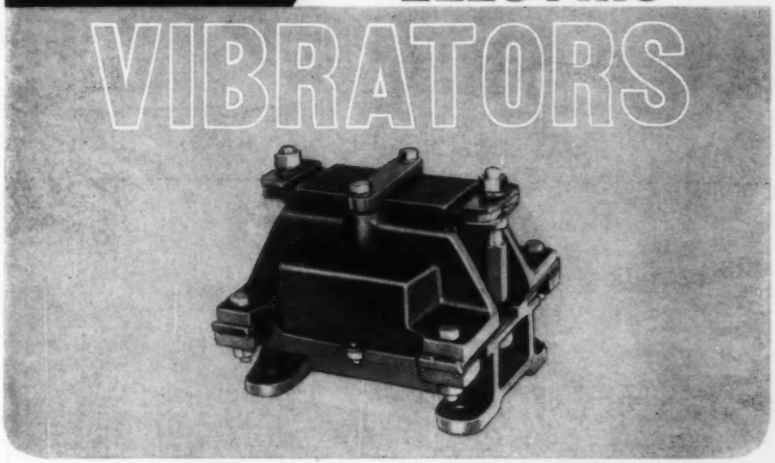
Centrifugal Pumps

A 12-page selection catalog for users of centrifugal pumps has just been published by Dean Brothers Pumps Inc.

Included in this condensed circular are charts showing the recommended temperature and pressure ranges for ten classifications of Dean Brothers Pumps, from −350 to +1000 F, and up to 1000 psig. Illustrations, brief descriptions, and specifications are shown for each. **—K-50**

KEEP BULK MATERIALS FLOWING FREELY

SYNTRON ELECTRIC VIBRATORS



ASSURE STEADY MATERIALS FLOW FROM BINS, HOPPERS, CHUTES

Syntron builds an Electromagnetic Bin Vibrator unit to meet almost every requirement. Prevents most types of bulk materials from arching or plugging in bins, hoppers, and chutes.

The Electromagnetic drive unit produces 3,600 instantly controllable vibrations per minute, providing a steady materials flow to processing equipment.

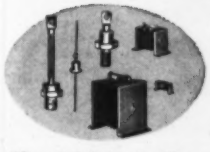
Every Syntron Electromagnetic Bin Vibrator is rugged and durable. The absence of mechanical moving parts assures long, trouble-free service with very little maintenance.

Keep bulk materials flowing efficiently and economically.

Write for a Syntron Catalog and the name of the representative nearest you. 6IV5

SYNTRON COMPANY
498 Lexington Avenue • Homer City, Pa.

Other Syntron equipment of proven dependable quality



Silicon & Selenium Rectifiers

Spiral Elevators

Packer & Jolters

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Pneumatic Conveyers

A revised bulletin, describing the complete line of Young Machinery Co. Transvair pneumatic conveyers, has been announced. Bulletin P-259-A describes negative and positive pressure systems, closed circuit systems and a variety of special applications.

Included in the bulletin are illustrations of major components utilized in pneumatic systems, a series of diagrammatic sketches showing twelve system variations, and a number of installation photographs with specific application data. —K-51

with a G-A *Cushioned*
Water Pressure Reducing Valve

No need to fear water line damage from high initial pressures with this Golden-Anderson valve on the job.

Regardless of upstream variance, this sensitive G-A valve always delivers water at the same predetermined pressure.

Complete technical details are in Bulletin W-3A, gladly sent on request.

Write for Bulletin W-3A

GOLDEN ANDERSON Valve Specialty Company

1210 RIDGE AVENUE, PITTSBURGH 33, PA.

Designers and Manufacturers of VALVES FOR AUTOMATION

Aircraft Bolt and Nut

Two bulletins covering a miniaturized high-strength aircraft bolt and a mating self-locking nut for applications up to 900 F have been released by Standard Pressed Steel Co.

The two four-pagers cover respectively the new LWB 922 twelve-point external wrenching bolt and the FN 922 twelve-point featherweight locknut. The bolt-nut joint is rated at minimum tensile strengths of 220,000 psi at room temperature and 170,000 psi at 900 F. —K-52

Ball Joints

How to easily provide for movement and flexibility in metal piping with simple ball joints is detailed in an eight-section Catalog 250 published by Barco Mfg. Co. Advantages claimed are simplification of engineering, elimination of involved pipe stress calculations, space savings, and reduction in pipe anchors or supports required.

Illustrations of the five basic motion principles of Barco Ball Joints serve as examples of how to provide flexibility in piping subject to contraction and expansion. Actual installations are also shown and explained. Sections of the catalog cover ball joints in sizes from $1/4$ through 16 in. with threaded, flanged or welding end connections and joints for high temperatures up to 1000 F and pressures. —K-53

Shaft- and Flange-Mounted Drives

Falk Corp. Bulletin 7100, 36 pages, presents shaft-mounted drives and a new series of flange-mounted drives covering a torque range up to 44,000 lb-in. Design and construction advantages are included as well as selection and dimensional data, engineering drawings, accessories, and typical application photos. Also explained and illustrated are the Falk Equi-Poised motor mounts for use with Falk shaft-mounted and flange-mounted drives; these compact, steel weldments are pre-drilled to accommodate rerated foot-mounted NEMA motors, $1/2$ to 30 hp. —K-54

Tracing Tissue

A tissue-thin natural tracing paper that is claimed "tough as leather" is described in a free folder available from Keuffel & Esser Co.

"Banknote" Natural Tracing Paper 185 is made of 100 per cent new rag fibres from virgin textile cuttings especially selected for their purity and strength, the folder says.

The folder points out that Banknote is made on one of the few Fourdrinier paper machines still employed that runs a "top jacket." —K-55

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Transite Pressure Pipe

A revised edition of Johns-Manville Corp. Installation Guide for Transite Pressure Pipe has been published. The Guide shows the latest product design information and field installation recommendations.

The Guide, TR-62A, covers the handling and installation of Transite Pipe, from loading and unloading through all necessary operations such as assembly of pipe and couplings, cutting and machining, design of thrust blocks, service connections, backfilling and tamping, testing, and many other on-the-job practices. It also contains data covering site conditions, soil and many other important considerations of interest to the engineer.

TR-62A contains 124 pages, and includes considerable tabular data plus numerous illustrations. An index to its contents is incorporated in the pocket-sized Guide. —K-56

Ductile Iron Valves

OIC Valves has released a 12-page brochure, Form 1011, covering Ohio Injector Co. new line of gate valves designed specifically for Ductile Iron.

The new brochure describes both the Pipe-Pal series of, 1/2 through 2 in., small gate valves featuring spiral-wound gaskets and a "spread flange design," and the Pipe-Mate series of, 2 through 12 in., large gate valves incorporating a new and stronger "buttressed flange" construction.

In addition to listing complete engineering specifications, pressure-temperature ratings, and testing data, the folder describes many applications for Ductile Iron valves. Included also is a description of the engineering properties of ductile iron and the advantages it offers in the valve field. —K-57

High Alloy Castings

A guide to the most economical method of purchasing high alloy castings is available from the Alloy Casting Institute, technical association of stainless steel and high alloy foundries. Titled "How to Buy High Alloy Castings," the article offers five rules to help the buyer obtain the best value when ordering high alloy castings: Specify alloys by casting type; give service conditions and specifications; give complete dimensions and detailed drawings; use good pattern equipment; establish realistic delivery requirements. Each rule is fully discussed, giving typical questions that should be answered by the purchaser.

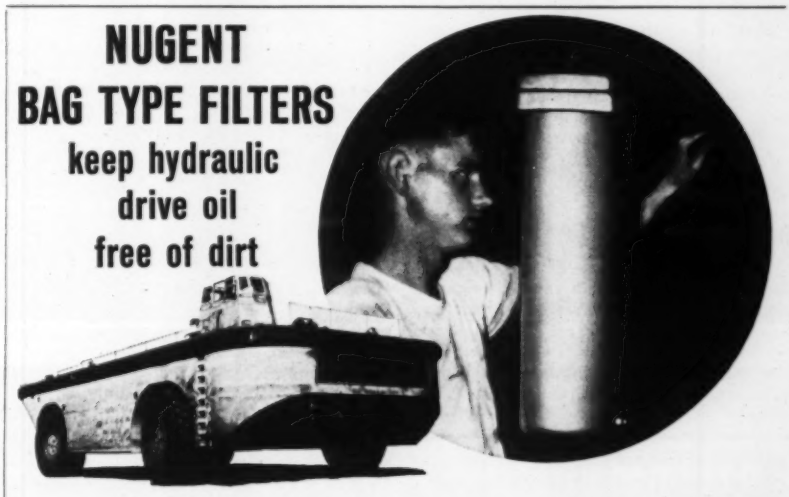
Included in the article is a complete chart of standard designations and chemical composition ranges for heat and corrosion resistant castings. —K-58

Drafting Machine

An illustrated four-page bulletin has been issued by V. & E. Mfg. Co., describing their Model 3300 drafting machine, with special emphasis on the 20-in. Arm model which covers a drawing area up to 34 × 44 in. These precision machines are claimed to have all the features usually found only in large, more expensive drafters.

Specifications for this as well as the 16 and 18-in. Arm models are included, together with a section on scales available for these machines. —K-59

NUGENT
BAG TYPE FILTERS
keep hydraulic drive oil free of dirt



Into the water, out of the water, on smooth roads, across rough fields and through desert sands the Amphibian BARC is propelled by Allison Hydraulic Drive for each wheel. Nugent bag type filters keep the oil in the hydraulic transmission clean for each wheel and provide instant response to meet various driving conditions.

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Constant-Speed Drives

Four basic split-system constant-speed drives for missile and aircraft applications are described in Bulletin A-5246 available from Vickers Inc. Div., Sperry Rand Corp.

The bulletin, which serves primarily as a design guide, covers four types of drives: Governor-controlled motor, throttle-controlled motor, flow-controlled pump, and by-pass controlled pump. Simplified schematic diagrams, performance characteristics and operating principles are given for each type of drive. Application considerations are discussed in detail. —K–60

Acrotimer

External clutch reset device combines functions of delay and interval timers, opening or closing one or more switches after an adjustable period of time. Well illustrated folder illustrates basic unit and accessory elements for twelve standard variations. Hydon Div., of General Time Corp. —K–61

Electro-Mechanical Equipment

An eight-page bulletin describes briefly some of Hoover Electric Co. line of electro-mechanical equipment, such as linear actuators, rotary actuators, rotary power actuators, direct current and 400-cycle a-c motors, and mechanical drive and control components.

Applications for these components are in military and commercial aircraft, missiles, ground handling and support equipment, and electronics. —K–62

Five and Ten-Ton Presses

A new catalog sheet, featuring the Havir Mfg. Co. Press-Rite JuniorLine Series covers the five and ten-ton presses, both standard and deep-throat models.

The presses are available for bench mounting or floor mounting as required, and are designed to operate in an upright or inclined position. These are all OBI presses with many outstanding features, including: anti-friction roller bearings flywheel, automatic cam actuated brake, single stroke safety mechanism, four-point heavy duty engagement clutch, and many others. —K–63

Ultrasonic Cleaning Primer

An ultrasonic cleaning primer has been prepared by the National Ultrasonic Corp. The 12-page booklet begins with a list of definitions of terms used in ultrasonics, then gives some ultrasonic cleaning hints. A list of contaminants removed and a list of parts which are being ultrasonically cleaned are included. A discussion of ultrasonic cleaning compounds follows. —K–64

Midget Air Cylinder

Hannifin Co. Bulletin 0230-B1 provides concise engineering data and specifications on the maximum 200 psi, Series S Midget Air cylinder.

Both universal mounting and nose mounting models in $^3/_4$, 1 and $1^1/_8$ in. bore sizes with standard strokes to 12 in. are fully described. Special reference is made to the four basic mountings inherent in the Midget Air universal design as well as the added versatility provided by optional mounting attachments. A cut-away diagram points out the internal and external features of this compact, small force air cylinder. —K–65

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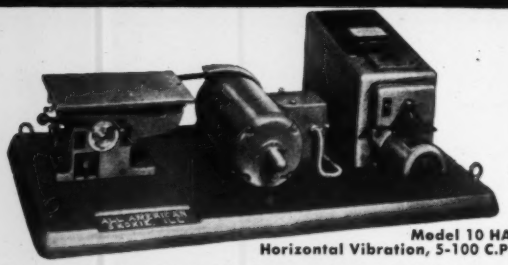

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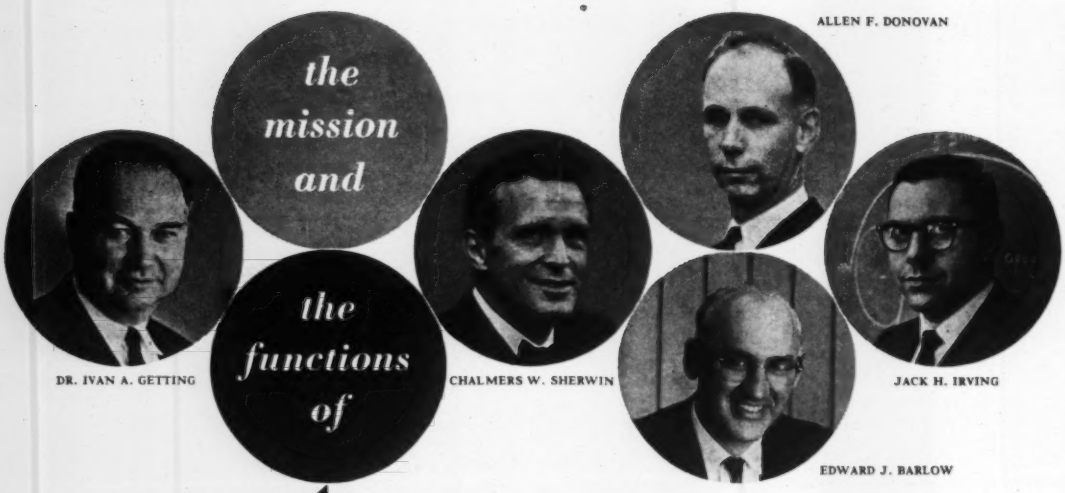

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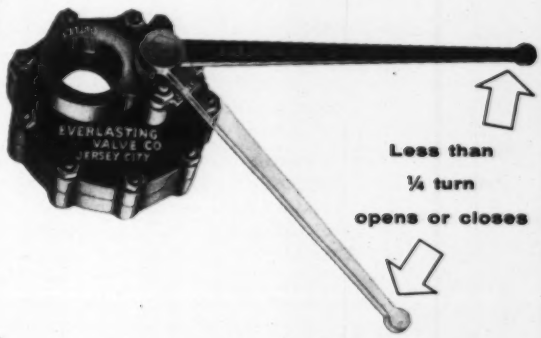

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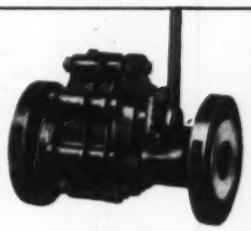

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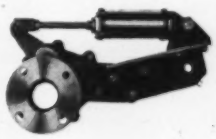

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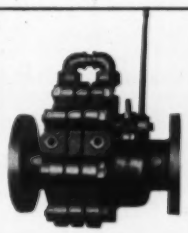

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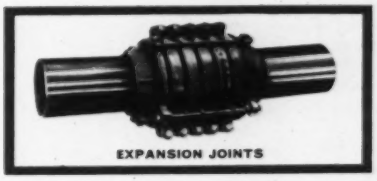
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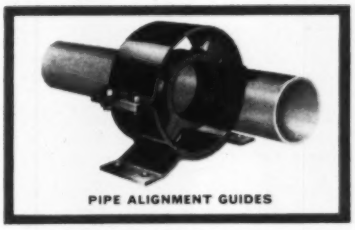
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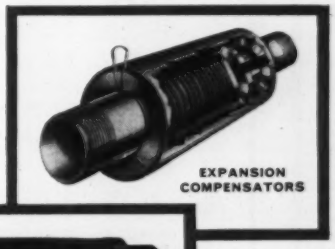
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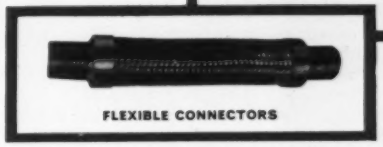
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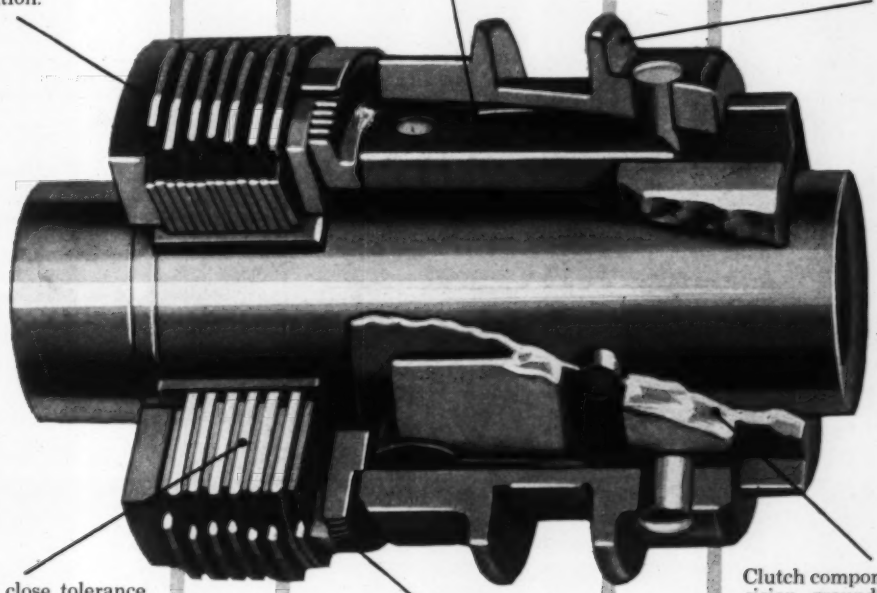

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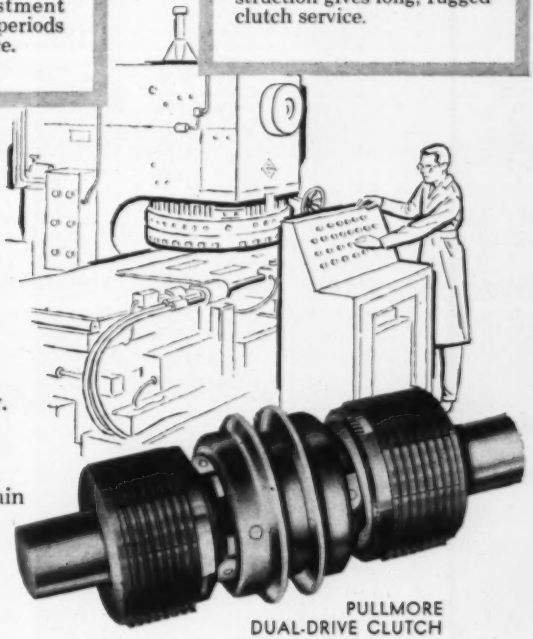

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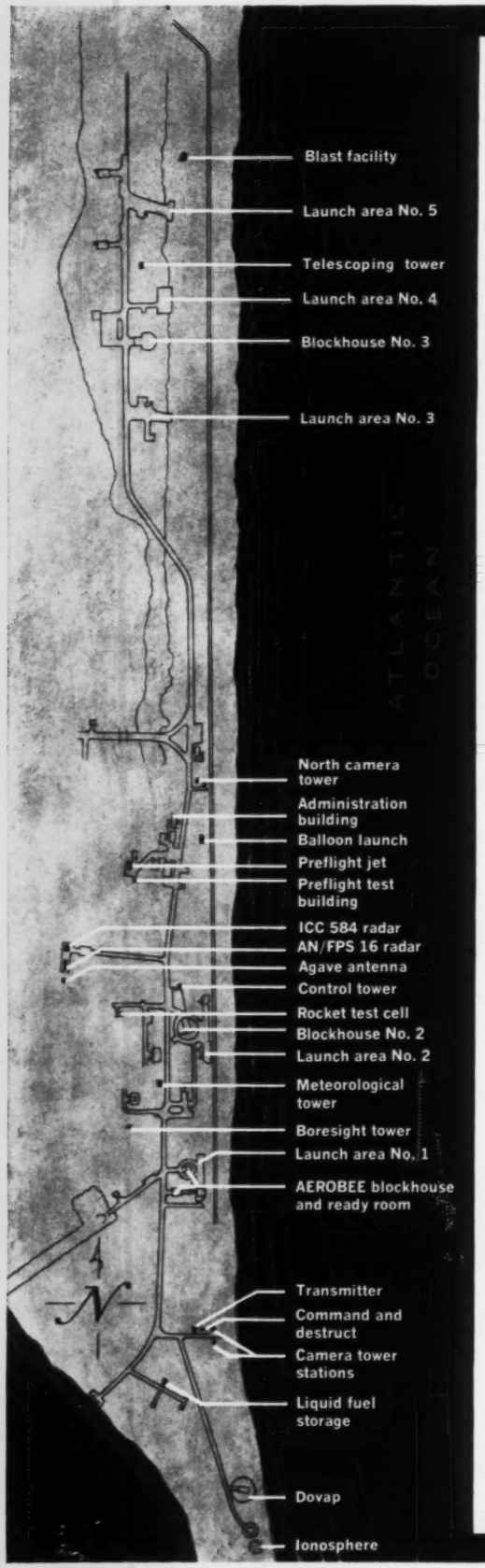

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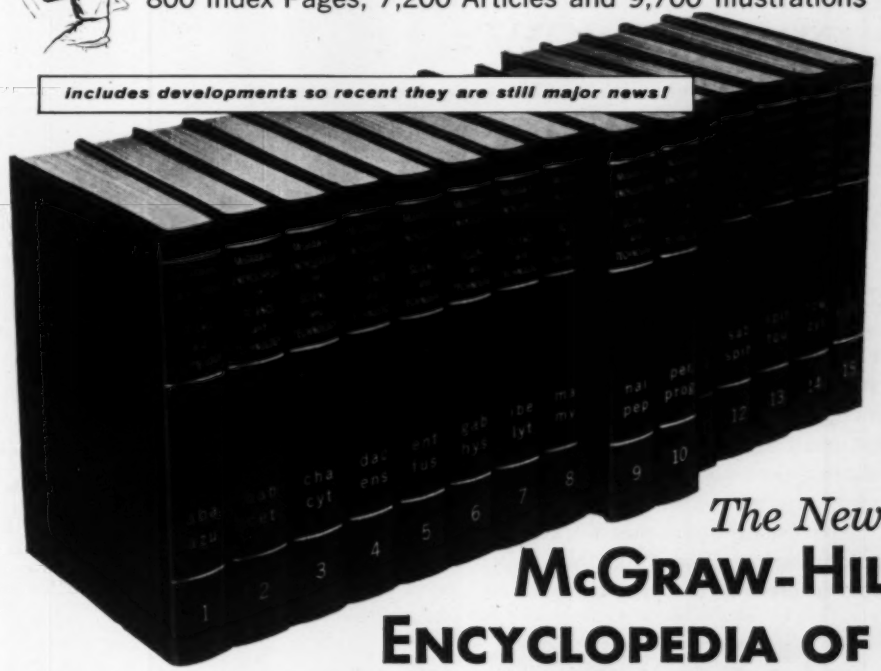

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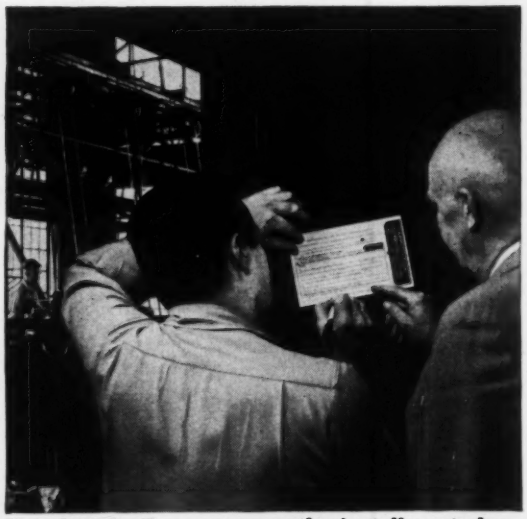

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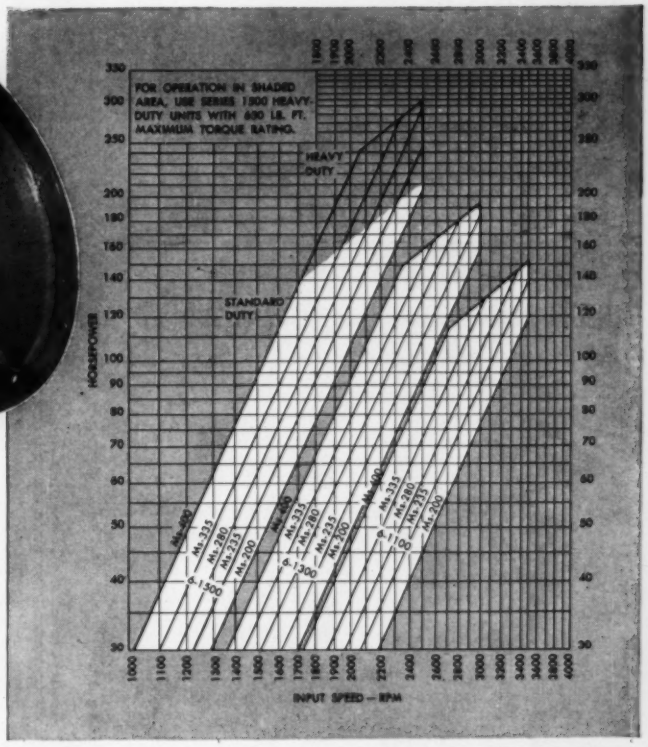
TWIN DISC

Torque Converters


FOR OPERATION IN SHADED AREA, USE SERIES 1300 HEAVY-DUTY UNITS WITH 650 LB. FT. MAXIMUM TORQUE RATING.
HEAVY DUTY
STANDARD DUTY
HORSEPOWER
INPUT SPEED — RPM

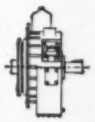
This chart gives horsepower and speed ratings for all Twin Disc Single-Stage Converters. Note that the 1500 Series is furnished in standard and heavy duty capacities. The figure "6" preceding the series number refers to the type of circuit.

"Stripped" or cartridge-type units for OEM in-line design

Nine models—11", 13" and 15" sizes.
Torque ratings from 235 to 650 lb.-ft.
Three types: Converter only; converter with oil-actuated disconnect clutch; and converter with disconnect clutch and lock-up direct drive clutch.

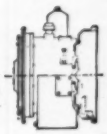
Basic power take-off units

Three models—13" and 15" sizes.
Torque ratings from 350 to 650 lb.-ft.
Suitable for side loads.



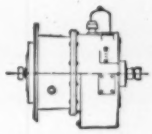
Spacer units for connection to transmissions

Three models—13" and 15" sizes.
Torque ratings from 350 to 650 lb.-ft.
Flanged output shaft.
Available with dummy flywheel for automotive type clutches.



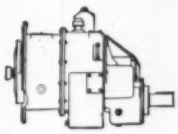
Units equipped with front-end disconnect clutch

Four models—13" and 15" sizes.
Single or double plate clutch.
Torque ratings from 350 to 650 lb.-ft.
Suitable for side loads.
Optional: Boom lowering freewheel for shovels and cranes.



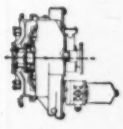
Units equipped with disconnect clutch plus 2:1 ratio reduction gear

Three models—13" and 15" sizes.
Single or double plate 11" clutch.
Torque ratings from 350 to 650 lb.-ft.
Suitable for side loads.
Optional: Boom lowering freewheel.



Sumpless PTO units for power-shift transmissions

Three models—13" and 15" sizes.
Live power take-off for auxiliary drives.
Torque ratings from 350 to 650 lb.-ft.
Flanged output shaft.
Optional: Rubber block input drive.



SINGLE-STAGE TORQUE CONVERTERS

25 models

Virtually any single-stage torque converter requirement can be met with one of Twin Disc's standard rotating-housing units. The scope of the Twin Disc line can be seen from the summarized listing at left.

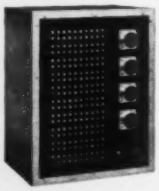
Each converter size—11", 13" and 15"—has five interchangeable impellers which vary with respect to blade number and pitch so that each has a different torque absorption capacity. This exclusive Twin Disc design feature provides a 2:1 horsepower spread for each converter series. It insures correct matching of converter to engine and also permits a subsequent increase in engine horsepower without dimensional changes in the torque converter.

Twin Disc Single-Stage Converters are available as "industrial" (self-contained) units or as "stripped" (cartridge type) units for incorporation into OEM transmission designs. Complete details are contained in Bulletin 510. For your copy, write TWIN DISC CLUTCH COMPANY, Hydraulic Division, Rockford, Illinois.

PACE
THERMOCOUPLE REFERENCE JUNCTIONS

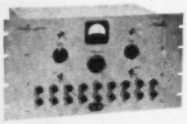
INSURE TEMPERATURE STABILITY WITHIN ± 1/10°F

Bridge stabilized for laboratory accuracy, PACE BRJ Series Reference Junctions are available with up to 100 channels. They are designed and built to operate reliably from the 115 volt 60 cycle line. Temperature stability and uniformity for long term unattended operation are within ±1/10°F. The instruments provide precision beyond the capabilities of ice baths and cold junction compensators and junction accuracy matching NBS calibrated premium thermocouple wire curves within ±1/5°F. Special models include below ambient and field adjustable reference temperatures.



Series BRJ Reference Junctions

PACE Model TC2R Thermocouple Control Units, when combined with a BRJ Reference Junction and any galvanometer type oscillograph, provide a complete system for the simultaneous recording of independent channels of temperature information. Two calibrating ranges of ±10 and ±100 millivolts are featured. A variable bucking voltage, range ±5 millivolts, is included.



Model TC2R Control Unit

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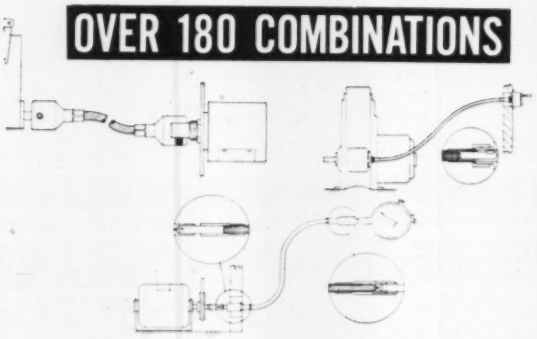

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They are composed of stock components, the finest steel cable, vinyl covered steel casing and cadmium plated coupling type steel and fittings.

We solicit your inquiry on Circle Ess Flexible Shafting.

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WEST COAST PLANT: 2404 So. Grand Ave., LOS ANGELES 7, CALIFORNIA

Nagle "KR" Pump provides economical disposal of ash from sludge incinerator at Nashville!

This Nagle 4" type "KR" pump provides economical disposal of wetted ash from a sewage sludge incinerator at the Nashville, Tenn., Sewage Treatment Plant. It is designed to handle this gritty, abrasive material which would soon wear out or clog an ordinary pump. Water and parts are of tough manganese steel. Impeller is readily accessible. Simple slippage seal adjustment. Packing gland within easy reach has trouble "designed out." Many plants are profiting from the use of Nagle Pumps. Send for Nagle Pump Selector.

Nagle Pumps, Inc., 1299 Center Ave., Chicago Heights, Ill.

Tough jobs call for

Nagle PUMPS
FOR ABUSIVE APPLICATIONS EXCLUSIVELY

Send for your

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- Sizes from 11" x 20" to 13" x 55"
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- Handles temperatures up to 1000°F
- Provides low-cost heat recovery with minimum maintenance for chemical processing, ventilating systems, air conditioning, drying processes, air purification, food processing, filtering systems, fume and dust control.

For your free copy of the ROTO-PAK[T] BOOKLET, write

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

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...PARTICIPATING IN THE NEW FRONTIER PROGRAM!

Boeing Airplane Company (where NORWALK compressors are in constant use) introduces the B-52 global bomber with America's first and only air-launched ballistic missile, the hypersonic Skybolt.

Always in the forefront with unexcelled quality, reliability and safety, NORWALK Compressors have been an integral part of America's frontier of industrial growth for almost 100 years. Forward-looking industry looks to NORWALK for custom-production compressors especially engineered for specific uses: from single stage to six stages; from 0 to 42,000 psi pressures; for all gases and air. All NORWALK equipment is built to meet the most rigid demands of every industry.

NORWALK COMPANY, INC.

SOUTH NORWALK, CONN., U.S.A.

COMPRESSOR SPECIALISTS TO WORLD WIDE INDUSTRY SINCE 1864

Phone TEmple 8-4766 (South Norwalk, Conn.) for prompt consultation. Catalog available on request.

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MONSANTO CHEMICAL COMPANY
Organic Chemicals Division, Dept. 4431E
St. Louis 66, Missouri

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Opportunity with expanding medium-sized manufacturer in growth industry for M.E. with machine design and industrial experience, who desires job with diversified duties. Mail confidential resume including salary requirements to—

AMERICAN BAG & PAPER CORP.
Water & South Streets, Phila. 47, Pa.

WANTED:
YOUNG ENGINEER TO START AT PLANT MANAGER LEVEL

Requirements

1. Not over 30 years old.
2. Scholastic record in top 25% of graduating class.
3. Good record of accomplishment in previous employment.
4. Must be willing to put forth the extra effort to be promoted quickly.

Information about the job and our company

1. Minimum starting pay $8,000. Applicants with outstanding record will start at a higher salary commensurate with experience and ability.
2. We are a leading producer of flexible urethane foams for the furniture manufacturing industry.
   This unusual opportunity for a young engineer is due to our phenomenal growth in an industry that is expanding very rapidly.
3. Present employment will be in Richmond, Va. We have additional plants located in the following cities:

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E. R. CARPENTER COMPANY, INC.
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VALVES and mechanisms for critical high-pressure, high-temperature services in the growing marine, petroleum, process and power fields—including nuclear power.

CONTACT J. M. Evan, Edward Valves, Inc., subsidiary of Rockwell Manufacturing Company, 1200 W. 145 St., East Chicago, Indiana.

ARMY QUARTERMASTER RESEARCH & ENGINEERING CENTER NATICK, MASSACHUSETTS

QUALITY CONTROL ENGINEER

$8955 per annum
— Career Civil Service Appointment —

Serves as specialist in the Mechanical Products Division for the establishment and administration of a quality control program. Work involves application of Quality Control techniques and methods relating to specifications for tests and acceptance of mechanical items.

Graduate engineer required who has had three years of professional engineering experience, at least two of which involved assignment to quality control phases in the manufacture of machinery or mechanical products.

Send resume or, preferably, Federal Employment Form 57 (obtainable at nearest Post Office or federal establishment) to Barbara K. Sullivan, QM R&E Center. In confidence, of course.

OLympic 3-1000 Natick, Massachusetts

DESIGN ENGINEER

This firm needs an engineer who has solid talent in the area of mechanical and electro-mechanical machine design and who enjoys exercising his talent both on the board and in the shop. This is a primarily-board work position concerned with the design of food processing machinery.

Candidates must have knowledge of and skill with:

1. **All standards related to mechanical machine design;**
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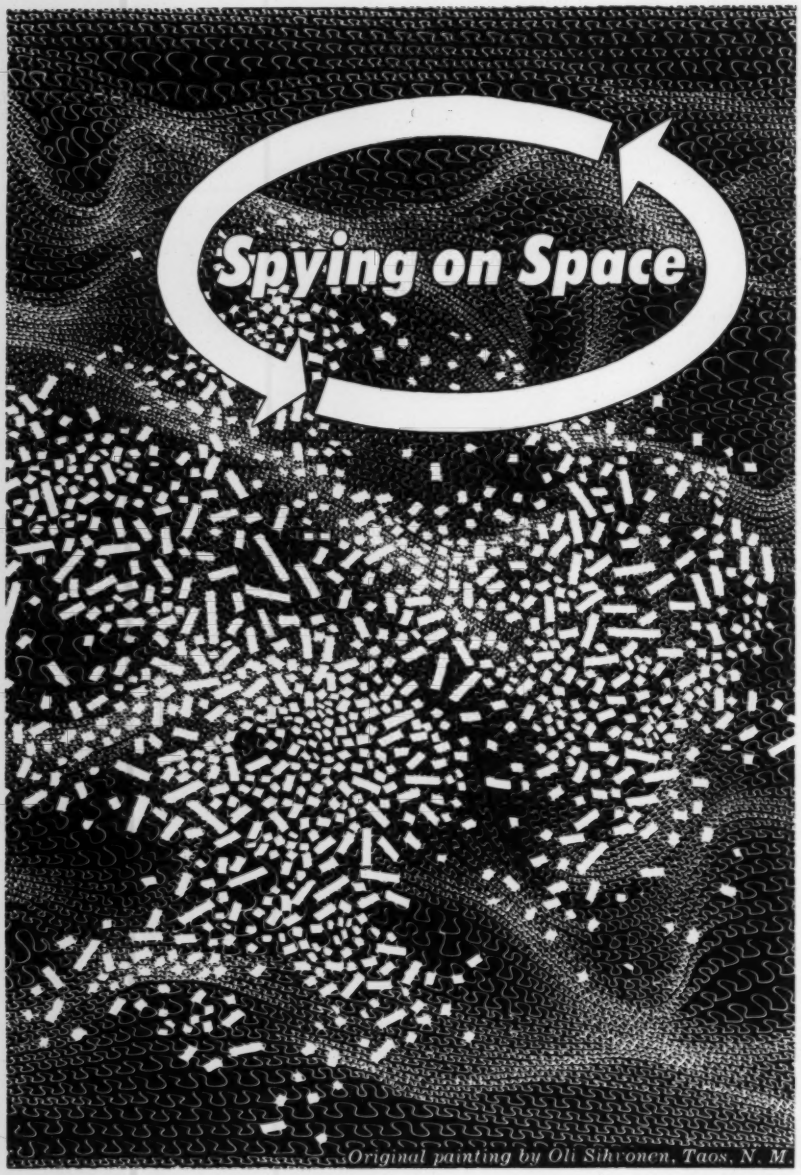
3. **Metals and metal-forming techniques;**
4. **Costs related to the above;**
5. **The ability to put all of this together into a high producing engineering effort characterized by inventive creativity.**

This is a truly professional-level engineering position. It is NOT administrative.

The Department is new and small and is part of a dynamic national consumer products corporation. Assisting and subordinate draftsmen are available. Position is located in our SOUTHERN CALIFORNIA headquarters.

Send resume including salary requirements.

Address CA-7124, care of "Mechanical Engineering."



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Through the use of tissue equivalent dose rate meters carried on various high altitude research rockets, Los Alamos scientists are learning much about radiation in space, including its possible effect on humans. The instruments simulate human tissue, observe the effects of radiation and telemeter the data back to earth.

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Director of Personnel Division 61-26

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MECHANICAL ENGINEERS

United Engineers & Constructors Inc. has attractive openings for Mechanical Engineers seeking careers in the fields of power and heavy industrial facilities.

B.S. in M.E. required with two to six years' experience in industry.

Full benefits, professional status, opportunity for advancement. Relocation allowance, Philadelphia location. Send complete resume to A. C. Eckerman.

UNITED ENGINEERS
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The Research and Development Division of a major paper producer has an immediate opening for an experienced equipment design engineer. This is a highly challenging assignment with excellent advancement opportunities in a growing company.

YOU SHOULD HAVE

1. Degree in Mechanical Engineering.
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3. Knowledge of strength of materials, mechanisms, and other engineering fundamentals as far as they apply to equipment design.
4. Ability to direct others in the preparation of detail drawings and layouts.

This is an excellent opportunity to use your initiative and creative ability in an atmosphere conducive to accomplishment.

Salary open. Age to 35.

Send complete resume in strictest confidence.

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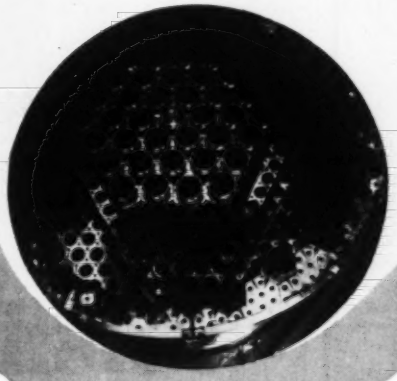
M.E. experienced in layout and design of industrial ventilation systems, dust control equipment and plant process equipment. Some experience in structural steel, re-enforced concrete and general machine design desirable. Board and field work. Openings also available for engineering trainees.

Permanent positions in old line expanding company in small rapidly growing community. Salary open—Top Benefits—Send resume to J. M. Gadway, Johns-Manville Products Corporation, Lompoc, California.

NUCLEAR / MECHANICAL ENGINEERS

First Nuclear Powered Flight Scheduled For Mid-60's...



VIEW OF REACTOR CORE, used in HTRE-3 Ground Tests of Direct-Air-Cycle System. Hexagonal fuel tube-moderator bars of hydrided zirconium assembled from center outward. Each tube receives single fuel cartridge. (ACTIVE CORE contains 150 moderator bars.) Small tubes standing alone hold control rods of clad europium. Reflector blocks of beryllium at periphery.

New positions created with General Electric now pushing ahead on flyable prototype of proven Direct-Air-Cycle Propulsion System

"It's no longer a question of 'can we build a practical nuclear power plant for aircraft'—but—'when do we fly it?'" says David F. Shaw, General Manager of General Electric's Aircraft Nuclear Propulsion Department.

December, 1960 saw the completion of a series of ground tests (HTRE-3) which demonstrated conclusively that G.E.'s Direct-Air-Cycle reactor can operate successfully as heat source for conventional turbojet engines.

Now it can be told...

Now G.E. can reveal some of the important achievements scored by the Direct-Air-Cycle program: engines started and brought up to normal operating performance on nuclear power alone; proof that power distribution in reactors can be flattened ±10%. *(For some actual performance figures, see chart at right.)*

Today G.E. engineers and scientists, under Government contract, are designing a high-performance Direct-Air-Cycle aircraft nuclear power plant. Concurrently a developmental aircraft is being designed. Both are scheduled for flight in the mid-60's.

Long Range Future for Reactor Systems

Flight testing is just a beginning. Much will be learned after the nuclear powered plane gets into the air. Progress from there on is immeasurable. While the first prototype is scheduled for a high-performance, high-payload, subsonic aircraft, nevertheless—with the technology now in hand—the potential exists to power a supersonic as well as an extremely high-payload subsonic vehicle. Other applications are in the offing: nuclear ramjets and rockets; space auxiliary power; energy for space propulsion (ion and magnetic engines); compact high-performance reactors for a variety of applications.

Long-Range Opportunities for Design Engineers: Nuclear, Mechanical

with nuclear experience—

Upper level positions for engineers with suitable background in Shielding, Reactor Design, Control Design, Powerplants, Thermodynamics.

without nuclear experience—

While experience in nuclear design is desirable, the engineer experienced in other fields of design (automotive, locomotive, aircraft) can adapt his skills readily to reactor components, working with G.E. experts in this field. Competent, inventive-minded men can go right to work on design optimization of reactor structures.

▶ ***If you have an interest, and qualifications in these areas, write in confidence to Mr. George Hunsinger, Manager, Professional Personnel, Room 41-MC.***

A DECADE OF MAJOR ADVANCES IN REACTOR TECHNOLOGY BROUGHT DIRECT-AIR-CYCLE TO "FLYABLE" STAGE

An important criteria in General Electric's original decision to develop an air-cooled reactor system for the flight propulsion program was the desirability from an engineering standpoint, of overall systems simplicity. In order to achieve it, G.E. engineers accepted the corollary requirement of pioneering a new regime in high temperature reactor technology. This challenge was met. Reactors capable of delivering air at temperatures of 1600° F were achieved.

Weight also was a key problem. Through research and development G.E. engineers have designed nuclear engine systems roughly 50 times better—in power-to-weight ratio—than in nuclear submarine power plants.

EXTRACTS FROM PERFORMANCE DATA RECORDED IN HTRE-3 AT IDAHO TEST STATION

		Predicted	Measured
Max fuel element temp	(°F)	1,880	1,900
Max moderator temp	(°F)	1,175	1,120
Max temp discharge air from fuel	(°F)	1,640	1,640
Average temp discharge air from fuel	(°F)	1,430	1,435
Reactor pressure drop	(psi)	6.05	6.2
Pressure drop, compressor to turbine	(psi)	10.8	9.3

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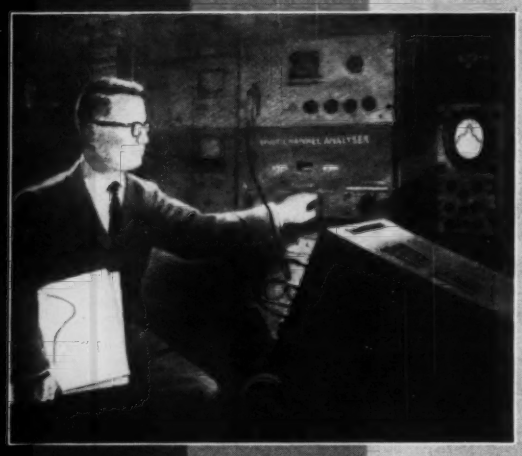

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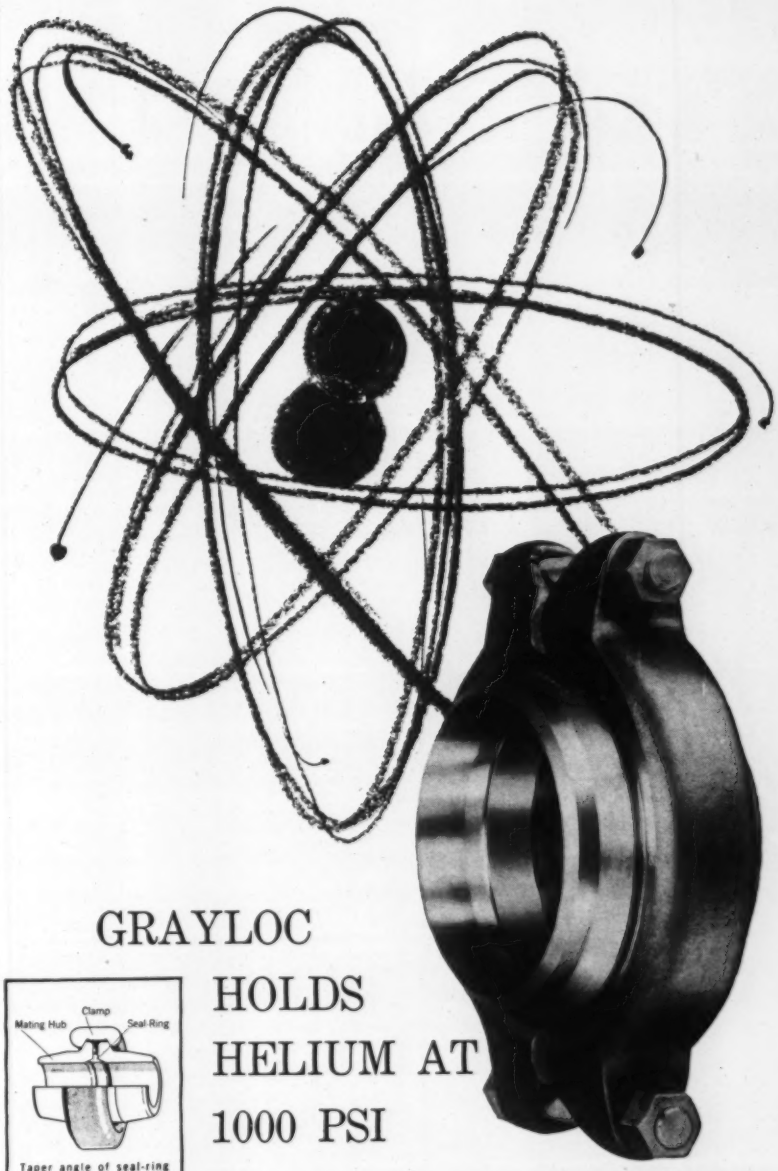

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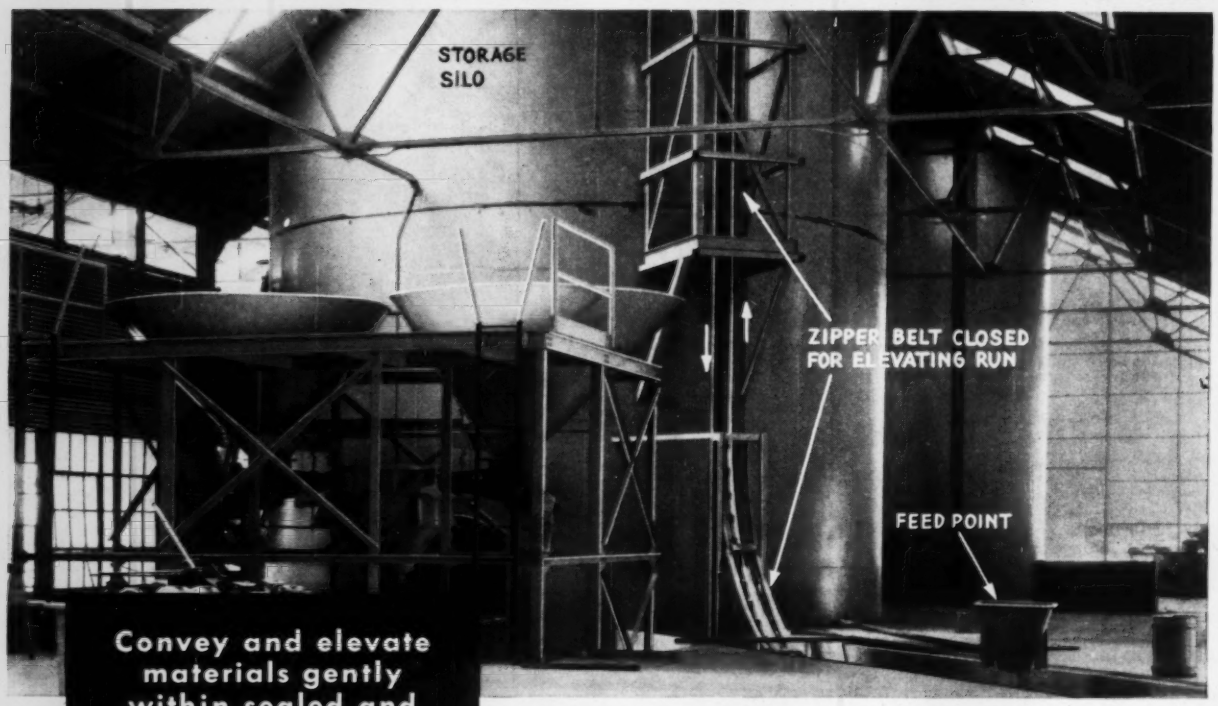

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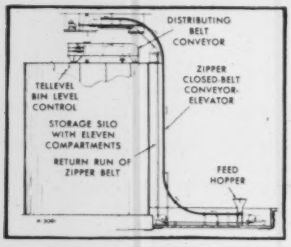
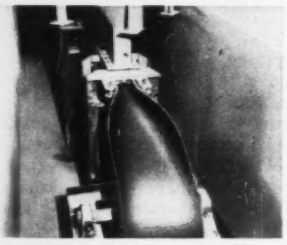
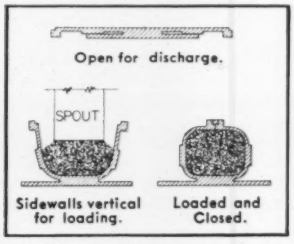


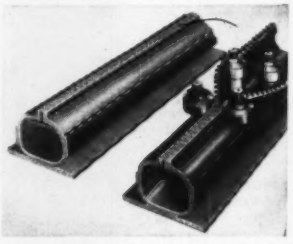
Drawing shows typical "ZIPPER" Closed-Belt, Conveyor-Elevator installation.



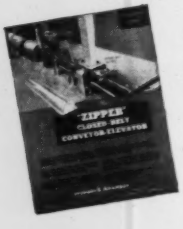
"ZIPPER" Closed-Belt Conveyor-Elevator shown open to receive material at feed point.



Loading and Unloading Cycle of "ZIPPER" Closed-Belt, Conveyor-Elevator.



Upper left, unit closed and loaded. Lower right, belt opened and closed by system of ball bearing rollers.



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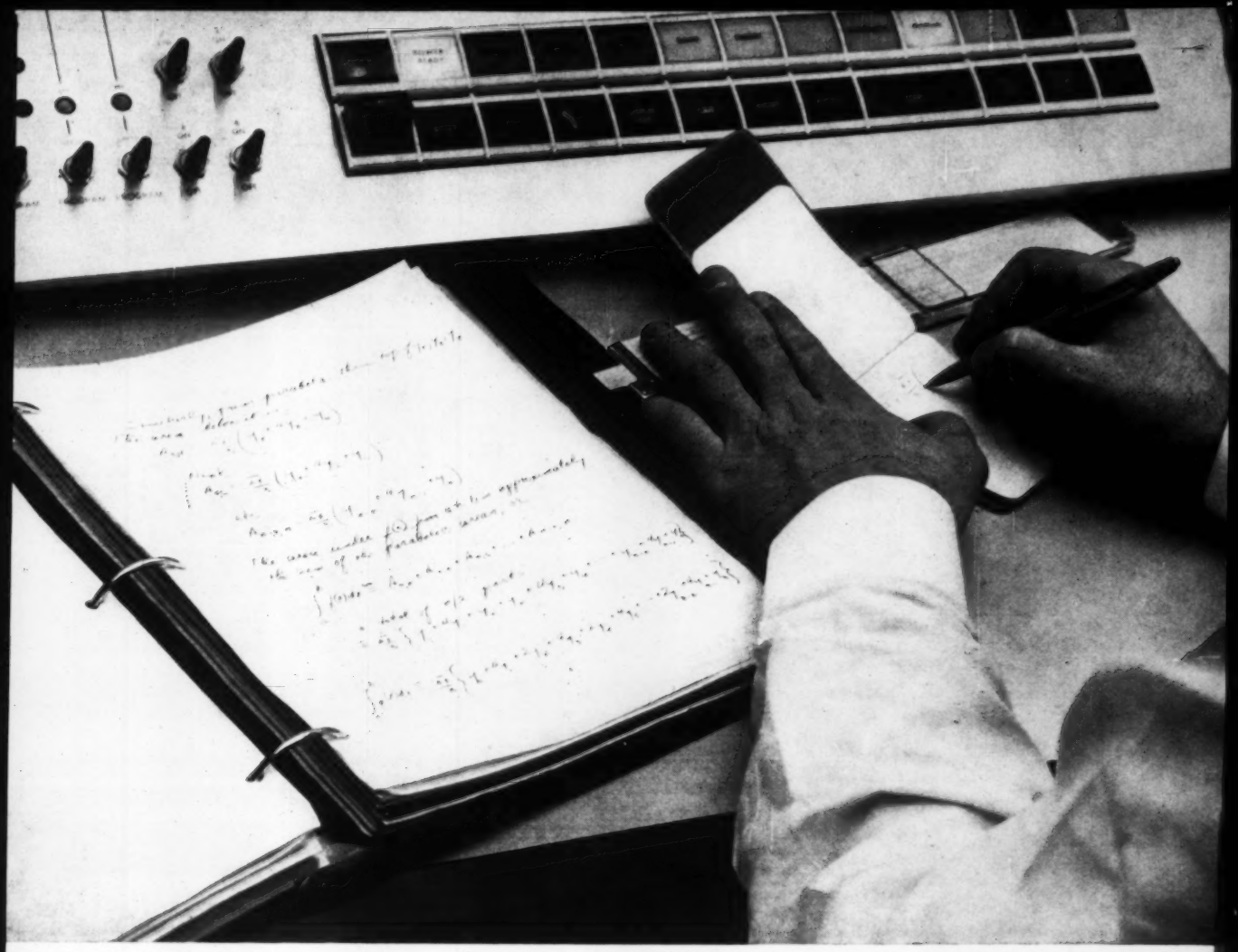

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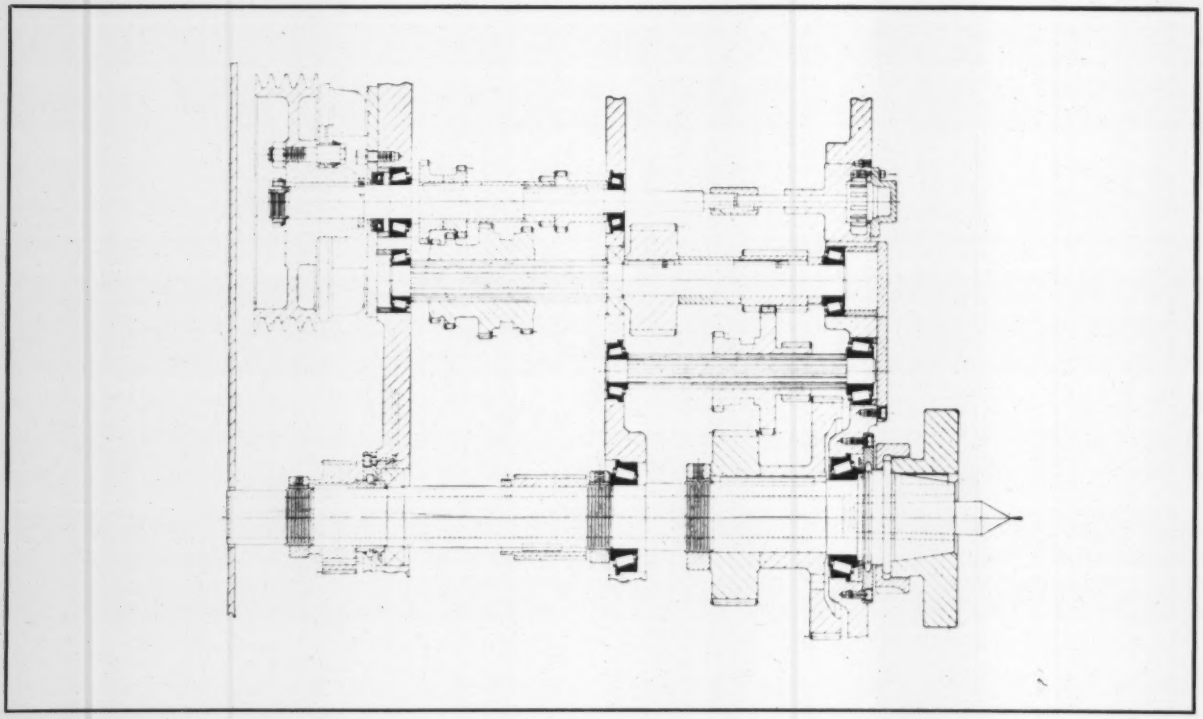
LeBLOND lathe obtains super spindle-runout of less than .000025″ with Timken® "00" bearings



To raise the already great precision of its 15″ Dual-Drive lathe to a special new high for a customer, LeBlond had to meet this requirement: spherocity of the part to be turned—a beryllium gyro float assembly—had to be concentric with its two major axes within .0005″ total indicated runout. Diameter of the sphere: 1.8750″.

To assure this, LeBlond engineers specified Timken® super-precision "00" tapered roller bearings held to .000025″ assembled runout for the spindle—one-third the normal runout tolerance for these bearings. Timken bearings were also used on the intermediate, back and feed shafts of the drive. The assembled spindle runout (total indicator reading) was actually less than .000025″.

Producing super-precision bearings like this is typical of Timken Company service. The kind of service that developed Timken "00" bearings to meet industry's needs for ever-greater precision. It's another example of the Timken Company's leadership in tapered roller bearing design and manufacture.

YOUR BEARING PROBLEMS can often be solved on-the-spot by our graduate engineer salesmen. Working with you at the design stage, they can help you select the Timken bearing to meet your special needs, save you time and money.

Industry rolls on

TIMKEN®

tapered roller bearings

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO." *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.* Canadian Division: Canadian Timken, St. Thomas, Ont.